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THE MATHEMATICIAN IN MODERN PHYSICS[1]

IT is perhaps presumptuous for an experimental physicist to address a body of mathematicians. He can at best appeal. They are the arbiters of his science. They determine the number of cubic feet allotted for his antics. In a genial mood, they may give him the equivalent number of cubic centimeters. Physicists appreciate the clemency. Let nobody contend that there are, *necessarily,* laws of nature. In science, as in civil law, the experts in a measure make the facts. So I appeal to the law-givers of physics, with a purpose of exhibiting something of the method with which they have supposedly treated me, in the past forty years of my experience. If I am obtrusively personal I must be pardoned, for this is the only experience I have to give.

We, the experimentalists, are supposed to be the artists of science, a type of men who reach conclusions by intuition, by a happy leap in the dark. The inventor, the laboratory hermit, parades an essentially feminine type of mind, whereas the eternal masculine, the essentially logical trenchency, belongs to the mathematician. In all humility, however, in the dark recesses of the laboratory, there are skeptics who believe that both the physicist and the mathematician, in the main, follow the method of trial and error; that both develop from idea to idea. The usual outcome in the mathematical case is a huge paper basket, overflowing and standing in the waste; the outcome in the other, a sort of dismal morgue, a junk-shop of botches. Failures have been the rule, successes the exception. But as we flaunt our successes (and they only

[1] From an address given at the dinner of the American Mathematical Society, in Providence, September, 1914, on the occasion of the one hundred and fiftieth anniversary of Brown University, by Professor Carl Barus.

can be indefinitely manifolded, like truth) while our failures are still-born, we are known not for what we are or actually do, but by the occasional incident, by the happy accident. And it is this incident that wills it that the results of the mathematician are much more glorious, soaring unfettered and free even into transcendental space, whereas the results of the physicist, as a rule, must be of the earth, earthy. While the mathematician indulges an oriental dream—"Nein, Wir sind Dichter!" cries Kroneker—the physicist must tread the straight and narrow path, guided by the arithmetic of the fathers. We are the Puritans, you the unmitigated voluptuaries.

Judge, therefore, the astonishment of the world that it was left to our brother of the soil to detect the four-dimensional world among the inadequacies, or shall I say the débris, of the three-dimensional. It is the journeyman of science that clamors for a wider scope. It is rule of thumb evidence that cries exultingly "we are living in a Copernican era." Things believed to be at rest are asserted to be moving and so uncannily moving, that if there were an Inquisition in power to-day, we should all, like Galileo, be put to the torture. Need we then blame the physicist if in his intoxication he suspects that the mathematicians may not, after all, be the only experts, that the laws of his undoing may have been, in a measure, of his own making?

However, I am digressing too far. I will, therefore, reconsign the experimental skeptic to the allurements of his workshop and there he may grumble as he chooses.

I implied that it is suspected that the mathematician makes our laws for us. It is thus necessary to indicate, however superficially, what I mean. When I began my work in Germany in 1876 the theory of Weber, "Das electrodynamische Grundgesetz" of 1846, was rife in that country and had even invaded France (*cf.* Briot, Thermodynamique) and the other countries of continental Europe. Electrodynamics through the genius of Ampère (1821–22), had already definitely captured magnetism. Weber embraced the whole of electromagnetics in a single equation, consistent with the law of the conservation of energy. It was a beautiful theory; but it was action at a distance gone mad. Such indeed was the rage of these theories at the time that even Gauss and Riemann did not escape temptation, while Clausius revised and modified the argument throughout, bringing out a new theory of his own. I doubt whether any one here has read that theory. I have never seen it referred to and yet it is a superb piece of vigorous mathematical reasoning, quite worthy of Clausius.

I am induced to pause for a moment to speak of Weber himself, a singularly lovable child-like man, to all appearances hopelessly unpractical, so much so, that many of his intimates were wont to poke fun at him. But Weber, like his friend Gauss, was a profound mathematical thinker and in that capacity introduced two of the most practical things which the practical world has inherited; for the electric telegraph is a Gauss-Weber invention (1833); and what we now call our C.G.S. system of units is fundamentally the creation of Weber (1852) again following Gauss (1832). A man may, therefore, be practical even if he sometimes fails to drive a nail straight.

To resume: what these men did was to postulate a force which depended upon the states or motion of the point where force originates; but any phase of the force hammers away at any distant point co-temporaneously with the time of its origin. These electrical forces, in other words, did what gravitational forces still persist in doing. If we glance back at such theories from our present point of vantage, we can not but marvel how perilously near they came to the state of the case as we know it to-day. If they had only retarded their potentials! It is all the more curious that they suspected nothing, as the 3×10^{10} velocity which characterizes the relation of Weber's electrostatic to his electromagnetic system of units, measured by Weber and Kohlrausch in 1856, is the velocity of light.

The respite accorded to any of these theories was brief. In England they were vigorously

condemned. Thomson and Tate, T and T', as we used to call them, in the earlier edition of their book anathematized them, as all the more pernicious in proportion as they were beautiful. They were completely swept away by the profound originality and incisiveness of the Faraday-Maxwell hypothesis (1854). Maxwell's great book (1873) had in fact appeared three years before I entered as a student, but it naturally was looked at askance in Germany, Helmholtz alone excepted. The aim of the earlier thinkers, to reduce the whole of electrical science to one equation was now to be realized in a way that marks one of the most important epochs in the history of physical science; an epoch comparable only to that of Newton; for although Maxwell modestly ascribes the incentive to his great accomplishments to Faraday, and believes that he is seeing nature with a mathematically unsophisticated eye, the capital discovery of the equations of the electromagnetic field (and this is the real issue) is Maxwell's creation. More than the widest sweep of the generalizing fancy could have anticipated was here completed; for at a single stroke of the wand, as it were, the whole domain of light and heat was annexed to electricity. It interpreted the meaning of the transparent and the opaque body of reflection and refraction. It introduced a new cosmical force, the light pressure long after found by Lebedew (1900), and our own countrymen, Nichols and Hull. It harmonized the divergent views of Fresnel and Neumann, admitting both impartially, and it gave to optics a new lease of life by lifting it over the obstructions of the elastic theory. Indeed Maxwell's best friends were apprehensive, since the theory predicted even more than was believed to exist, until in 1877 the new Maxwellian light dawned upon the mind of Hertz. The theory endowed the world medium, the ether, with new potencies, in insisting on its continuity, on the point to point transfer of electric force, so that ether stress became one of its familiar images, a veritable charm to conjure by.

It would carry us too far if we attempted to analyze the reaction of the new views on kindred sciences. Hydrodynamics, which had suggested the useful conception of the force-flux, in particular, profited and such beautiful researches as those of the Bjerknes (1863 *et seq.*) father and son, were stimulated in proportion as they fitted into the electromagnetic scheme. It was inevitable, moreover, that in the further treatment of Maxwell's equation the use of vector methods of computation should become indispensable in physics. They were approached cautiously enough and at first rather regarded as an affectation. Maxwell himself merely indicated the use of quaternian methods. Helmholtz, so far as I know, made no use of them. But in spite of petty differences of notation which still persist, the vector method became more and more general until to-day it is a commonplace, and beginning to make room for the new and more powerful 4, 6 and 9 dimensional geometry of higher vectors.

This was the second epoch and an epoch of unexampled fruitfulness. The ether electrically ignored heretofore has become all embracing. Woe to him that lisps, action at a distance! That Maxwell should have died before the ultimate vindication of his theory on the part of Hertz or the appearance of important corollary of Poynting (1884) is one of the tragedies of science. Similarly Hertz was not to witness the spectacular development of radio-telegraphy which followed so soon after his death. Maxwell's theory, which according to Hertz means Maxwell's equations, thus includes the whole of physics, dynamics alone excepted, and the world equation has advanced another step. Maxwell indeed, following the established custom, endeavored to call dynamics to his aid; but here his questions were put to a silent sphinx, inasmuch as mechanics had no counsel to give. Naturally the theory so revolutionary gained headway but slowly on the continent of Europe and even in England, unfortunately, Kelvin and (I believe) Rayleigh long remained unconvinced. When therefore the theory was universally accepted, it was already ripe for the modification, which Hertz himself actually began.

The ether as Maxwell left it has two independent properties, specific inductive capacity and permeability, which may be regarded as associated in the velocity of the electromagnetic wave passing through it. But the equations apply only for a medium at rest or at least approximately at rest, to a quasi-stationary medium. It is fortunate that a very coarse approximation to rest suffices; otherwise the early workers would have lacked encouragement. The new epoch, now about to dawn, thus found its point of departure in the motion of electrical systems. It has been in the main an era of confusion and bewilderment and one was to learn the hopelessness of any fundamental proof in physics. Instead of subjecting physics to the arbitrament of dynamics, we see dynamics pleading at the gates of electrical science, when electricity, distraught within itself, has no fundamental interpretations to offer. The troubles begin with the study of the first-order effects of moving optical systems, in the researches of Fizeau (1851); they become grave in the famous experiment of Michelson (1881) where the effects to be observed are of the second order. The speed of the earth, regarded optically from axes fixed in the ether, is zero. The ether and the earth have no relative velocity. This is tantamount to a rejection of the ether. Judge the consternation! As Maxwell's equation contained no direct reference to the motion of the charged body, a first attempt as I have already intimated was made by Hertz (1890) to supply this deficiency; but it was not of permanent value. The real interpretative advance came from Lorentz, in 1892. Although he fully realized and had endeavored to explain away the Michelson difficulties, Lorentz none the less boldly put his coordinates in an absolutely fixed ether, penetrating all bodies, even the atoms. He then went back to the methods of Weber, but with this essential difference that he included the whole dictum of the Maxwellian electro-magnetics in his postulates. The peculiar feature of the ether, its permittance and permeability, were abolished and in their place appears the velocity and density of the electron, or charged particle. Electric fluid exists; magnetic fluid does not. Lorentz then showed with consummate skill that the equations of the classic electromagnetics of Maxwell could be retained, that both the scaler potential and the vector-potential would retain their original form, would be invariant, so to speak, if the time-variable were belated by the interval consumed by light in passing from the source to the point of application in question. The profound originality and power of this and the earlier Lorentz transformation would perhaps not have been detected so soon, but for the unexampled abundance of new resources accruing to experimental physics at this time. In 1892 Lenard had isolated the cathode ray; Röntgen in 1895 discovered the X-ray. As a sort of corollary of the X-ray came the Becquerel-ray in 1896; the radium of the Curies in 1897, soon to be interpreted as to radiation by Thomson and Rutherford. The year 1896 brought the Zeeman effect, virtually predicted by Lorentz. The year 1898 brought Thomson's electron. In these and similar researches, bodies moving with a speed approximating that of light (easily exceeding $c/10$) were for the first time in history, at the disposal of the investigator. The new bodies, showing an inertia or virtual mass depending in a pronounced way on their speed, made havoc with Newton's laws and swept the classic dynamics mercilessly out of the field, as an arbiter of world phenomena. Theories such as those of Lorentz, 1892, or of Larmor, 1894, were now the only refuge. What could they do, was the ardent question, to replace dynamics?

Following the suggestion of Lorentz that the moving system contracts in the direction of motion, or at least apparently contracts to the fixed witness, Einstein in 1905 was the first to clearly perceive the iron logic of the situation; and the logic of a desperate situation is all there is in the theory of relativity. Einstein saw that if systems were to be interconsistent, time periods in the moving system would have to expand in the same second-order ratio to the ken of the fixed observer, so that time specifications and time frequencies may proportionately contract; or

that identical clocks in the moving system must go slower. In such a case, any natural phenomenon, preferably a vacuum phenomenon like the velocity of light, is the same in all systems, moving or at rest. One system is as good as another. All observation is relative. The equations of this celebrated principle of relativity, culminating in Einstein's famous addition theorem of velocities belonging to different systems—an ultimate break with the Galileo transformation, where time has the same absolute value everywhere—have been the very focus of discussion for the last ten years.

In its original form, the principle is as yet rather a detached statement, adapted to definite purposes but lacking in mathematical elegance. It was left to the genius of Minkowski (1908) to mould this flotsam of ideas into a philosophical system of extraordinary symmetry and breadth, the promise of which it is, as yet, too soon to adequately appreciate. In fact, the untimely death of Minkowski was an irreparable loss to science, even if with Hilbert we resignedly conclude to be grateful for what he has done for us. Minkowski's world, as he himself remarks, is a response of modern mathematical culture to the urgent demands of the laboratory, and therein lies its strength. In the minds of prominent thinkers it is a philosophical revolution, an inversion of thought, as far-reaching in scope as the similar revolution of Copernicus. "Let space and time be submerged," cries Minkowski in an impassioned utterance, "Sie sollen in den Schatten versinken," to make way for a single unified world; in other words, let the incantation ring in a world in which the variables x, y, z, t, are linked with ties as inherent and indissoluble as the variables x, y, z, in common space. So understood, every point in space, even if at rest, describes a world line, which may be referred to and is contained between the two extremities of the time axis. Uniform motion is a straight world line. Any other motion an appropriately curved world line. World time is the length of a world line in relation to the speed of light. These world lines are thus a veritable warp and woof of the Deity. With Goethe we may say "Sie weben der Gotheit ewig Gewand"—or recall the curious passage of Wagner's Parsifal "Du siehst mein Sohn, zum Raum wird hier die Zeit."

To establish the connection between the four variables which shall be invariant in case of linear time transformations as is the case in Newton's dynamics, or that shall embrace the Einstein transformations as a special case, Minkowski postulates a four-dimensional hyperboloid with a single parameter c, the velocity of light, given by the reciprocal of the time axis. The other parameters are one. The hyperboloid is now usually made equilateral by calling the time variable ct. The intersection of the xt-plane with this hyperboloid, thus cuts out two hyperbolas symmetrically above and below the x-axis, the former (for positive time) alone being considered. The major axis is again the reciprocal of c, the minor axis a unit.

Now if the hyperbola in question with its parameter c is referred to conjugate diameters, it is easily shown that the oblique time and x-axes imply all the transformations of the theory of relativity, for the same c. The equation of the hyperbola is an invariant with relation to the new axes. The axes, or units of measurement, are proportionately increased, the specifications or numerics decreased, but the ties of the variables are exactly the same as before. Minkowski calls this the group G_c. Velocities greater than c are imaginary and are thus essentially excluded.

On the other hand, if the parameter c be supposed to increase to infinity, the symmetrical hyperbola eventually coincides with the x-axis, eliminating the time axis, and referring the whole system back to Newton's dynamics. This is the transitional group G_∞.

The generalized time is then the new variable of which x, y, z and t are all functions. Every translational vector now has four components and the rotational vectors six components, corresponding to the six pairs of variables or planes of rotation. One may even add that the new world, like Cæsar's Gaul, is divided into three parts by the asymptotic

cones unknown to Cæsar. Axes may be so chosen as to make any two events contemporaneous. They need merely be parallel to the time axis selected. Similarly there are four equations of motion, the fourth being the energy equation, as energy itself is possessed of inertia. Finally, the equations of electromagnetic field in their magnetic and electric aspects, like the rotations, are given by the geometry of a vector with six components.

The treatment of motion is thus profoundly generalized, and Minkowski remarks that if these new transformations had been discovered by a mathematician "aus freier Phantasie," by an untrammeled imagination, they would have constituted a triumph in mathematics of the very first order. But, even under present circumstances, as soon as such developments were demanded by the laboratory, finding that within the atom the Newtonian world is certainly discredited, mathematics was at once ready to embody the new conception in a way that makes the bonds of mathematics and physics closer than before.

Vast and beautiful as these generalizations are, we must nevertheless confess that they are still but a coarse reproduction of nature; for in none of them is there any unequivocal or imperious demand for gravitation. Gravity still acts at a distance, as did the electrical vector in the days of Weber. Nor is the most generalized electromagnetic field able to account for the spectrum distribution of radiation, in the development of which energy threatens to pursue, if it has not already entered, the route of atomistic physics occupied by chemistry.

While mathematics is easily able to cope with the problems of relativity, even in their most generalized aspects, since they never break with continuity, the questions are more menacing in the second class of the recent demands of experimental physics, which came to a crisis in certain straightforward experiments on radiation made at the Reichsanstalt (Lummer and Pringshen, 1899; Christianson, 1884). The question dates back to Kirchoff's black body (1859), in which emission and absorption are equal. Some time after came Stefan's universal law of black body radiation (1879) and the theoretical verification on the part of Boltzmann in 1884. There was a period of intermission, in which the question of the equi-partition of the energy of a gas among the degrees of freedom of its molecules was vigorously discussed but without leading to available conclusions. However with the introduction of the black body by Kirchoff and the treatment of its radiation as a case of thermodynamic equilibrium, it was possible to assign both temperature and entropy to such radiation. But there was one further fundamental step to be taken and that was the definition of entropy apart from the Carnot engine and the intelligent manipulator, who is always an implied part of that wily machine. The second law was to be freed from reference to anything of a biological nature. Helmholtz had often insisted that the second law is the result of the order of physical size of the agent, in comparison with the atomic size, of his lack of equipment to control the individual molecule. To a being of molecular dimensions, there would be no irreversibility; whereas irreversibility has a very real meaning to the grosser attributes of the corrupter of nature. It was to the genius of Boltzmann (1877) that the fulfilment of this task was allotted. He was the first to give to entropy a purely mathematical signification, defining it as the logarithm of the probable occurrence of any thermo-dynamic state, be it a distribution of velocities, be it a definite distribution of discontinuous radiation energy-elements. Along this line, therefore, the new thermodynamics proceeded effectively. The first step came from W. Wien, whose displacement law of 1893 is embodied in the shift of the maximum of spectrum energy density, from red to violet, with increasing temperatures. Wien showed that a universal function of the ratio of temperature to frequency must here be in question. The determination of this universal function was the culmination of the insight and consistent labors of Planck (1900), who by postulating the energy quantum, became the creator of modern thermodynamics; for this energy element is a saucy reality, whose

purpose is to stay. It not only tells us all we know of the distribution of energy in the black body spectrum in its thermal relations, but it gives us, indirectly, perhaps the most accurate data at hand of the number of molecules per normal cubic centimeter of the gas, of the mean translational energy of its molecules, of the molecular mass, of the Boltzmann entropy constant, even of the charge of the electron or electric atom itself. Under the guidance of Nernst it has created new chapters in the treatment of specific heats at low temperatures, their evanescence at the absolute zero of temperatures, the evanescence of the specific electrical resistance at zero, all more or less bearing on Dulong and Petit's law. Not less vital is the introduction of the new universal constant hitherto not even suspected, the "Wirkungs quantum," an equivalent of the Hamiltonian integral of action. Here then is a departure from continuity postulated for energy, which will hereafter operate with definite finite elements only. The condition of occurrence of such elements in any definite relations, can for this reason be specified as a case of probability.

Of the Planck molecular oscillators I must speak briefly. If operating continuously under the established electromagnetic laws they lead to the impossible distributions of energy in the spectrum investigated by Rayleigh and Jeans. But if emitting only, when their energy content is a whole number of energy elements, a case thus involving the entropy probability of Boltzmann, Wien's law and the numerical data referred to are deducible with astounding precision.

This then is the peculiar state of physics to-day. The appearance at the very footlights of the stage, of a new constant, the meaning of which nobody knows, but whose importance is incontestable. Moreover energy is seen there under an entirely new rôle. Grasping at greater freedom she has hopelessly involved herself in the meshes of the doctrine of probability. There was a time, the time antedating Mayer (1840–42) and Joule (1843), Kelvin and Clausius, when to speak of indestructible energy would have been rash. It was a glorious epoch when she first appeared in the full dignity of her conservative and infinite continuity. In contrast with this, the energy of the present day is scarcely recognizable. Not only has she possessed herself of inertia, but with ever stronger insistence she is usurping the atomic structure once believed to be among the very insignia of matter. Contemporaneously, matter itself, the massive, the indestructible, endowed by Lavoisier with a sort of physical immortality, recedes ever more into the background among the shades of velocity and acceleration.

But the single equation of nature, aimed at by Lagrange and Hamilton, by Weber and Maxwell in their several ways, has nevertheless throughout all this turmoil reached a more profound significance and now even holds dynamics, awkwardly it is true but none the less inexorably, in its grasp. That it is not complete, that it never can be complete, is admitted (for the absolute truth poured into the vessel of the human mind would probably dissolve it); but that it is immeasurably more complete to-day than it was yesterday is as incontrovertably true as it is inspiring.

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CONTEMPORARY UNIVERSITY PROBLEMS[1]

THE story of Clark University during the quarter century of its existence, the close of which we celebrate to-day with the alumni, under the inspiring guidance of Dr. French and his committee, has in some respects no parallel in academic history. Especially the first few years of our annals have both brighter and darker pages than I can find in the records of any university. Thirteen of us instructors had taught or taken degrees at the Johns Hopkins, and we left that institution, which had added a new and higher story to the American university, when it was at the very apex of its prosperity and hence were naturally

[1] Address given on the occasion of the celebration of the twenty-fifth anniversary of Clark University by Dr. G. Stanley Hall, president of the university.

inspired with the ideal of taking the inevitable next step upward, as indeed were all the other members of our original faculty, which was remarkable, if not unpredecented in this country, in its quality. Of the no less notable original board of trustees, every member of which has now passed away (while death has not once invaded the ranks of our professorial corps), the triumvirate, Hoar, Devens and Washburn, who stood nearest to Mr. Clark, as his executive committee of all work, estimated the resources that were ultimately to be at our disposal at from eight to twelve million dollars, and very likely more.

I was at the outset sent on an eight months' trip to Europe, with several score letters of introduction, including one from the national government which gave me access to the inside workings of *Kultus Ministeria* and university circles and archives, so that my trip constituted a pedagogic journey I think almost without precedent. Twenty-five years ago these very weeks I was on this unique mission and was surprised to find the most eminent men of learning in Europe profoundly interested in it, and so lavish with their time, sympathy and counsel. I was entertained by Lord Kelvin, Pasteur, Helmholtz, Jowett, and some scores of others of the greatest living leaders in scientific thought; went on a trip of inspection of German universities as the guest of the Prussian Minister of Education, von Gosslar; perhaps most embarrassing of all, was taken in state by General Trepanoff on a visit to the two great Russian military schools near St. Petersburg, in each of which an all-day's program of military evolutions had been arranged for my special edification; was a guest of honor at a meeting of Swedish universities, etc. My instructions from Mr. Clark had been to see everything and every institution possible, collect building plans, budgets, administration methods of every kind, and find out a few of the best men who might be willing to come to a new institution here, but to engage no one, but to be ready to negotiate with them later. The amazement to me was how lavish everybody was of advice, how cherished and often how elaborate were the ideals of university men, many if not most of whom seemed to have imagined installations of their own departments rivaling not only Bacon's House of Solomon, but sometimes almost suggesting apocryphal vision. From my voluminous notes of that trip could be compiled ideals lofty, numerous and far-reaching enough to inspire all the universities of the world for a century, and to organize a new one here for the conduct of which ten times ten million dollars would be sadly inadequate.

They gave me plans of the then new four-million-dollar university building at Vienna, of the new Sorbonne at Paris, its rival, of the complete new university which Bismarck had established at Strassburg to show Alsace-Lorraine, which Germany had just annexed, and to show especially France, what the Teutons really meant by higher education, of the newly built university at Kiel, in which Germany sought to impress upon the Scandinavians the same object-lesson in her newly acquired Schleswig-Holstein, and which was designed to compete with the neighboring university of Copenhagen, just as she rehabilitated Koenigsburg to impress the same lesson upon the nearby Russian rival institution at Dorpat. I was given in some cases the secret *état* and the unprinted *Statuten* of the universities,—all this until I felt an almost Tarpeian embarrassment, especially as I was in nearly all these places utterly unknown and an object of interest solely because of my unique mission. I found young professors prone to see visions, and old ones to dream dreams, each for his own department, that all a king's ransom would be inadequate to make real. Of all this I wrote Mr. Clark and my colleagues here awaiting the great instauration. The harvest home-coming, with all these sheaves of suggestion and inspiration, marked the zenith of great expectation and of hope tiptoe on the mountain-top. For years and sometimes even yet, European savants who first heard of Worcester from me and have since known it only as the home of Clark University, seemed often, to our great embarrassment, to assume that many or most

of the ideals that we then discussed together are now realized in this golden land of promise, and rank us far above our own modest sense of our deserts.

If I came home slightly intoxicated with academic ideals, so were all of us in some degree, according to our temperament, but a reality that was sobering enough soon confronted us. I can not enter here upon the details of our disappointments, culminating in the tragic hegira to Chicago and elsewhere of three fifths of our faculty. If ever there was an academic tragedy, a *via crucis*, a veritable descent into Avernus, it was here. The story of these years has been carefully written out, with everybody heard from, and all the divergent interpretations of what occurred and what it meant faithfully set down, and filed away in our archives, and perhaps after another twenty-five years or yet another, it may be published.

Suffice it to say that although we started with far less than, justifiably or not, we had hoped for, we began the fourth year, 1893–94, with only about one fourth of the total annual resources that we had the first year. In the seven years that followed, down to the founder's death in 1900, we had for all purposes only four per cent. of the income of $600,000 plus that of $100,000 more for the library, that is, less than $30,000. Several of us who remained here were tempted by larger offers to what seemed more promising fields, but, on the whole, and I believe no one regrets it, we elected to stand by here. These lean years were, however, characterized by two features. First, they were years of unique harmony. There was no friction. We stood and worked shoulder to shoulder. And this is of prime importance in a small institution like this. In a great university discords can and always do occur, but here, where discontent in any department disturbs the whole institution, accord is one of the prime necessities. The other feature of these years was intense devotion to research and to teaching, and our productiveness, whether compared with our numbers or our income, has never been greater, and indeed, I wonder if that of any other institution has been greater relatively to its size. Perhaps the alumni of these days were, and will ever be, a little nearer to the center of the hearts of those who went through them, and it is significant, and can be no cause of jealousy to others, that it is they who are leading in the epoch-making activities that center about to-day and mark this as the date from which henceforth our alumni will be a potent factor in our future history. Their newly and well organized support, their enthusiasm for the spirit of research, which is our inspiration, will henceforth greatly reenforce all our best efforts here and be an inspiration to our future development.

With the dawn of the century came also the college, which has given us 51 students who have already taken degrees in the last eight years, although it has its own independent purpose. As to it, we are brethren, children of the same parent or, to change the figure, a married couple, and unlike married couples we can never be divorced, so that he who would make discord between us is an enemy to both, and every man who helps the other is a friend to both. Any encroachment of either upon the other's domain or any effort to profit or exalt the one at the other's expense, is bringing discord into sacred family relations. Our two-in-one or dual unity is unique, delicate, imposes new responsibilities and presents also inspiring possibilities for a new solution of some of the highest academic problems. I think we can truly say that each is now a noble stimulus to the other. We are proud of the college and we are so just in proportion as we know and understand its problems, aspirations and achievements. We are proud of the name and the work of its first great president and of the rare men he brought here, whose growth in knowledge and power, together with those of the college alumni whom they trained in his day, constitute his living monument, and we of the university salute the college colors in our decorations to-day, and hail with pride and give our heartiest Godspeed to the second president of the college, who is not only carrying out the ideals he inherited of a three years'

course of non-athletic and citizen-building functions, but is going further and making the college a leader and light among others in the land. Would that some one would offer a prize for some pregnant symbol, seal or even slogan or song typifying this unique conjunction, which college and university should forever unite to use! Could we not fitly commemorate this occasion by a new resolve that there shall never be tension or strain between us, and that a policy of mutual help shall henceforth animate us both?

In the recent voluminous literature on colleges, so much under discussion of late, we have several characterizations of the ideal college professor, and these agree pretty well. He must be a good man, a model citizen, a gentleman and a scholar, a teacher born, made or both, tactful, and in close personal relations with his students, anxious and able to teach them all they are capable of learning in his department, a man whose character will be normative and influential for good, fitting students, not for the university, nor even for professional or technical careers chiefly, but for their work in life in general, and evoking all their powers. Noble as are all these traits of nature and nurture, and rare as is their combination, and exacting as are the conditions of instruction and parental care, many college professors go further and are not even content with the useful work of making text-books, but really add to the sum of human knowledge by their researches, and it is a satisfaction to us that so many of those here are with and of us in this respect.

For the university professor research is his prime function. He must specialize more sharply, must not only keep in constant and vital *rapport* with everything that every creative mind is doing in his field the world over, but he must hear and lay to heart every syllable that the muse of his department utters to every co-worker everywhere, and best of all, she must also speak new words through him. There is a vital sense in which he stands in closer relation to his co-workers in other lands than to his colleagues in the same institution. The chief momentum of the vital push-up in him impels him to penetrate ever a little farther into the unknown, to erect some kiosk in Kamchatka, where he can wrest some new secret from the sphinx, who has far more to reveal than all she has yet told. Whenever he grows impotent to do this, he becomes only an emeritus knight of the holy ghost of science. Studies of the age when men in various departments do their best work show that scientists are the oldest of all the creators of culture values on the average, but that there is more individual variation, so that they cross the dead line both older and younger than any others. It is one of the hardest things in the world to be and remain a productive investigator. There are so many journals and books to be read, so many and constant alterations and adaptations, needful to press the questions we ask nature home and to get an answer, such changes of methods and apparatus, so much that was yesterday new and will to-morrow be obsolete if we would not abandon what Janet calls "*la fonction du réelle,*" and take some kind of flight from reality and its ever-pressing *devoir présent.* But if research is hard and the life it demands beset with dangers, so that many are always falling by the way without giving any sign of their demise to outsiders, this work has its supreme reward, and I can not believe that there is any joy life has to offer quite so great as the Eureka joy of a new discovery.

Not only this work itself, but its conditions are amazingly complex, unstable, and ever shifting. Just at present it seems to me that academic unrest was never quite so great the world over, and that the near future never promised so many important changes. Some abuses, great and small, have of late grown rank and demand remedy. Certain vicious tendencies must be corrected and reforms made. Bear with me if I ask you to glance briefly at a few of these.

Beginning with the Teutonic countries, since 1907 the assistant professors and docents have developed a strong inter-institutional organization against the head or full professors. The unprecedentedly rapid growth in the size

of the student body everywhere has resulted in what Eulenberg calls a lush "*Nachwuchs*" of assistants of all grades. Statistics show that on the average the *Extraordinarii* or assistant professors receive this appointment at the age of 37, at an average salary of $523, and remain in this position nearly 20 years, attaining an average salary of $1,200, before promotion, at the average age of 57. These now constitute, with the docents, about half the teaching personnel of German institutions, and they often have neither seat nor vote in the faculty and little participation in the corporate life of the institution. In the municipal university which opens at Frankfurt this fall it was even proposed to have a president of the American type, to safeguard the assistants against the oppression of the full professors. A few years ago Tübingen, and last year Zürich, radically revised their ancient statutes to remedy these evils, and the projected university at Hamburg will go yet further. The two new universities in Hungary, at Pressburg and Debreczen, and the private one at Hongkong—these grant more liberty and show more appreciation of the enthusiasm and ideals of the younger members of the faculty. Even students in Germany have caught the spirit of unrest, if not revolution, and now have a strong inter-institutional organization, and their pamphlets are boldly demanding better methods of teaching, printed outlines of professors' lectures, are trying to develop a sentiment that no instructor shall ever repeat in a lecture anything he has ever published; are calling for more options, especially more freedom of choice in the selection of subjects for their theses and more meaty topics for them that do not make their work ancillary to that of the professor, more personal rights to what they produce or discover in them, a longer period of *hospitieren* or of trying out each course before they finally sign for it, more and better seminaries with better tests for admission, more practical courses, better access to books, journals and library facilities generally, less overcrowding and more elimination all the way from *Ober-Sekunda* in the *Gymnasium* to the doctorate, better social opportunities, dormitories, more personal contact with the professors, less restrictions on their personal liberty, reform of the corps, honor system and the *Mensur.* This unrest, although it seems ominous to conservatism, can not fail to prevent waste and bring reform.

In the English universities agitation has had many recent expressions, from Lord Curzon's demand for reforms in 1909 on to Tillgard's of last year. Here the protestants grant that these institutions still breed the flower of national life, the English gentleman, but demand better library facilities than the individual colleges, with their wasteful duplication, afford, and especially more of what the critics so strenuously insist is still lacking and that parliament should enforce, namely, more teaching and research. Thus the deepening sense that something rather radical must be done seems now crystallizing into just what that something should be. In France and in Russia unrest is greater and reforms are more loudly demanded.

In this country academic unrest has been largely directed against organization and administration. In the old days the college president, though he usually taught, was supreme and autocratic, and as leading institutions grew and he ceased to teach, the concentration of power in his hands became altogether excessive. The foundation of new institutions, the Hopkins, and a little later Stanford and Chicago, greatly augmented his power under our system. He had to determine the departments, select professors, fix their status, build, organize, represent the institution to the board and public, perhaps the legislature, plunge into the mad, wasteful competition for students and money, lay supply pipes to every institution that could fit. Never was the presidential function so suddenly enlarged nor its power so great and uncontrolled as a decade or two ago. Even the University of Virginia and other southern universities, which had only a president of the faculty, elected by its members, fell into line, and a reaction toward democratization, which in its extreme form seemed sometimes

almost to adopt a slogan, "*Delindus est prex,*" was inevitable. In the Cattell movement abundant incidents of arrogance and arbitrary, if not usurped, power were collected, and it was even insisted that although charters or conditions of bequests, to say nothing of American tradition, would have to be reversed, it was urged that the president should be only chairman of the faculty, elected perhaps annually by them, and in the literature of this movement we find occasionally the radical plea that some or all of the powers of the board should be turned over to the faculty, who should at least be given control of the annual budget. More lately the movement of protest here is against the autocracy of the dean, whom the president had created in his own image, and who sometimes exercises a power that he would never dare to do, and who in large institutions has constructed a mechanism of rules, methods, procedures, standards, which have almost come to monopolize the deliberations of the Association of American Universities, which fortunately can not prescribe or legislate for its individual members. University deans have often created rules which they themselves can suspend for individuals, and this has greatly augmented their power. It is they largely who have broken up knowledge into standardized units of hours, weeks, terms, credits, blocking every short cut for superior minds and making a bureaucracy which represses personal initiative and legitimate ambition. Just now perhaps we hear most remonstrance against head professors and statements that the assistant professors and younger instructors in their departments are entirely at their mercy, that they are burdened with the drudgery of drills, examinations, markings, all at small pay, while their chiefs take the credit, so that the best years of the best young men, who are the most precious asset of any institution, or even of civilization, are wasted. Indeed we have vivid pictures of the hardships which often crush out the ambitions of young aspirants for professorial honors and tend to make them, if they ever do arrive, parts of a machine with no ideals of what sacred academic freedom really means. Happily now the best sentiment of the best professors now organizing inter-institutionally to safeguard their own interests and those of their institutions, stands for a most wholesome and needed movement which is sure to prevail.

So far I submit to you and to my colleagues that Clark University, not through any wisdom or virtue of its president, although perhaps a little through the fact that he is a teacher and does not spend all his time in organizing, but owing to its small size, its unprecedented absence of rules, its utterly untrammeled academic freedom, is to-day in a position to lead and not to follow in the wake of this movement. No one here wants autocratic personal power, but we do all want the best attainable, whatever it is. Each department here is almost as independent and autonomous as if there were no other. We have no deans, few assistant professors, and so no tyranny of departmental heads, no complaints on the part of students, as in Germany, that we are not doing the best we can for them, so that this world-wide movement for academic reform we ought to consider as a great and new opportunity to us all, trustees and faculties, at this psychological moment to realize our own advantage, and to carefully look over our present system and see if we can not use this opportunity to begin the new quarter century with our lamps retrimmed and burning bright, and alert and profiting by every suggestion that the academic *Zeitgeist* is now murmuring like the Socratic daemon in our ears.

Let us, then, look our present situation and ourselves frankly in the face. With the indefatigable labors of Senator Hoar in securing a just and legal execution of Mr. Clark's difficult will, labors which some of his colleagues in the board thought almost justified us in calling him our second founder, with a board more active and interested in our affairs, external and internal, than ever before, as their cooperation in this commemoration typifies, with our funds better invested and yielding a trifle more than they have ever

done, with an admirable library, the creation, body and soul, of Dr. Wilson, who has the greatest genius of friendship of us all, with the reestablishment of the department of chemistry, which was dropped for a few years, with the increase of salaries, from time to time, as far as means permitted, inadequate though most of these still are compared with the increased cost of living; with more departments and professors and instructors—we seem to have entered upon a settled period of prosperity and growth that promises that the next quarter of a century will far transcend the past, and, now that all the perturbations of the first formative era are over, we can look forward with confidence that the university will go on in the general direction it has already so faithfully held to during its period of storm and stress, *in sæcula sæcularum.*

We have no greater distinction than that which has come from always preferring quality, attainment and ability to numbers, and that these standards may never be lowered is the most heartfelt wish and prayer of all of us. My greatest joy to-day is in the spontaneous testimonials of appreciation and loyalty of our alumni in leaving their work and coming here, at this most inconvenient season and sometimes from a great distance, and giving us or wording their cordial personal greeting and Godspeed, and even in contributing, not out of their abundance, for most of them are moderately paid professors like ourselves, but from a sense of gratitude and as a token of good will, to the fellowships which constitute our very greatest need.

Turning to the future, the changes we need here are largely but by no means wholly in harvesting what we sowed at the start and assiduously cultivated ever since, for which the time is now ripe. It would be preposterous to lay out our course now for another quarter century. We must always maintain keen orientation in an ever wider and more intricate field. To my mind there should always be a specialist here and in every institution in what might be called the higher pedagogy and in academic history, whose business it is to keep keenly alive to all that is doing in academic life the world over. Especially now, when these changes are so rapid, some one must spend much time in the outlook tower, and I would even hazard the strong opinion that, had foreign institutions had a specialist in the conning tower, intent on studying the ever changing signs of the times and trained in academic statesmanship, many, if not most, of the errors that have caused our own and foreign universities so much waste of energy in recent years, might have been avoided.

The time is at hand when university rectorates, presidencies, chancellorships, or whatever their name, can no longer be filled by any professor or even outsider who can secure election, but will require men who, whatever else they are or know, are experts in the history of the higher culture and its institutions, from the four great academies of antiquity down, who know the story of mediæval universities of the church and then of the state, of the guilds of scholars, the rise and present status of learned societies and academies, the great reforms of the past and the yet more significant reconstructions now evolving, the governmental patronage of learning and research, from the day of the Medici down to contemporary legislation for higher institutions, national and state, present-day centralization and the efforts against it in France, the many universities lately established by colonial policies, the world-wide movement of university extension. He must suggest ways and means to his colleagues for achieving their own even if unconscious ideals; help free investigators to be the supermen they are called to be, each in his own way, have a minimum of arbitrary authority and a maximum of faculty cooperation, catch and sympathetically respond to and find his chief inspiration in the fondest, highest, if secret, aspirations of each of his coworkers, who must not be content with the stale ways of the present perfervid competition for dollars and students or with the mere horizontal expansion, the multiplication of machinery or devices for efficiency of factory type, but study precedents, culture trends, and believe profoundly in the power of faculty

democratization and do his utmost to develop it, regardless of his own personal or official prestige or authority. On the continent, mayors are trained professional experts, and cities vie with each other competitively for their services and find they can well afford to do so, for their special training means vast economies. Universities in this country, if not the world over, are more nearly ready than are cities to profit by this example, and their gain thereby would be even greater. Twenty years ago Professor Paulsen, of Berlin, the best representative of the higher pedagogy I plead for which that country has yet produced, warned German universities of the very dangers which have now waxed so grave, and with which they are battling, and the presidents here have only too good reason to look either with jealousy or with hope, according to their temperaments, upon the now rapid addition of the higher story of academic pedagogy to the old schoolmaster's pedagogy of the grammar and high school, and development in this direction is another of the pregnant signs of the future.

Think of the changes since we began. Many special lines of research have their own institutions where little or no formal teaching is done, like astronomic observatories, the Rockefeller Institute, Wood's Hole, Cold Spring Harbor, the Carnegie Institution, with all the possibilities of his will, the question of a national university, always with us, just now of the Fess hundred-million-dollar type, to be devoted chiefly to research, the enormous expansion of teacher-training in nearly every higher institution of this country, a movement that is almost without precedent in its magnitude and suddenness, the augmented stress laid upon practical applications of pure science—these constitute a new environment, as also do the active and well-organized but silent field agencies of most large institutions both to recruit students, with competing agents at the ear of every boy who thinks of going on, and also to place their graduates in every academic vacancy. These are problems to which a presidential or other agency must give great and growing attention and for which the president of the future must have special training, and in which also the faculty must share the burdens of administrative responsibility since questions must often be decided one way or the other, while those who determine them are uncertain, themselves, so that criticism accumulates.

As to professors, the best of them make an almost unprecedented sacrifice and could have achieved the highest success in financial, professional, political (witness President Wilson) and other lines. They know the price they pay and are willing to pay it, but must have as their compensation the boon of security and liberty to teach and investigate freely what and how they will. The university professorate, too, means not only the cult of specialization but of individuality. Even idiosyncrasies are to be not only tolerated but respected and perhaps welcomed. The university should be the freest spot on earth, where human nature in its most variegated and acuminated types can blossom and bear fruit. The factory type of efficiency has no place there. Each must make himself as efficient as possible, but in his own way and independently of all external circumstances, and without the multiplication of machinery, so that an able organizer with nothing to do but to administer might prove an unmitigated curse to all the best things a professor and even a university stand for.

Thus now I, who with one tiny exception, have never, during all these twenty-five years, to a single citizen of Worcester hinted at a donation, will say a word which I wish all would hear and consider. We greatly need and shall always need more funds to strengthen existing and to found new departments. Though we bear another name, we are, fellow citizens, your University of Worcester. In all the spheres we touch, we have spread the name and added to the fame of this Heart of the Commonwealth. If we had ten million dollars more, not one of us would gain personally, but should only have more work, for we are only administering the highest of charities.

If you doubt that this is the highest, listen

to the conclusion of the report of the most elaborate parliamentary commission Great Britain ever knew, of forty volumes and nearly nineteen years in the making, covering all British charities of every kind, more than twenty thousand in all, which is: that of all objects of charity, the highest education has proven wisest, best, and most efficient of all, and that for two chief reasons, first because the superior integrity and ability of the trustees who consent to administer such funds, together with the intelligent appreciation of those aided by them, combine to furnish the best guarantee that they will be kept perpetually administered in the purpose and spirit of the founder whose name they bear; and second, because in improving higher education all other good causes are most effectually aided. Since the first endowment of research in the Greek academy, porch, grove and garden, from which all our higher institutions have sprung, thousands of spontaneous free will offerings have borne tangible witness to the sentiment so often and vividly taught by Plato, that in all the world there is no object more worthy of reverence, love and service, and none that it pays a civilization better to help to its fullest development than well-born, well-bred, gifted, trained young men who desire to be masters in an age when experts decide all things, for in them is the hope and the future leadership of the race, and to help them to more of the knowledge that is power is the highest service of one generation to the next. And how this has appealed to all ages! Oxford and Cambridge have 1,800 separate endowed fellowships and scholarships, to say nothing of the smaller exhibitions. Leipzig has 407 distinct funds, the oldest dating 1325, and wherever the higher academic life has flourished we find scores of memorials bearing the names of husbands, wives, parents, children, and providing for students of some special class, locality or establishing or benefiting some new department or line of investigation, theoretical or practical; and now that the *rapport* of business, government and all social and cultural institutions was never so close, all who give greatly and wisely, or who make or suggest bequests, have a new *noblesse oblige* to consider.

Cold facts and figures finally show a few things that I beg you all to ponder now. These are, that compared either with the size of our faculty, the number of departments, or our annual budget, we have fitted more men for higher degrees, seen more of them in academic chairs, where they are found in all the leading institutions of the land, including some dozen of presidencies, first and last, published more original contributions which seek to add to the sum of the world's knowledge, have a larger proportion of members of our faculty starred as of first rank in Cattell's census of the competent, had closer personal and often daily contact with students, and given more individual help outside of classes, had more academic freedom (for no one in our history has ever suffered in any way for his opinions), had more autonomy in our departments, each of which is a law to itself, had less rules and formalities of every kind, and had a president who was less president and more teacher, good or bad, spent less time in devising ways and means of seeking contributions from our friends here, advertised less and avoided all publicity more, until now, when I am, just for this one moment, throwing all our traditions of silence, modesty, absence of boasting about our work, to the winds. In these respects we exceed any of the other twenty-four institutions of the Association of American Universities.

This Clark University means, has stood for and will forever stand for, and this is why we all love and have put the best twenty-five years of our lives into her service and wish we all had another quarter of a century to serve her better. This is what brings you alumni back with your offerings, your loyalty and hearty good wishes. This is the university not made with hands, eternal in the world of science and learning. Clark University is not a structure, but it is a state of mind, for wherever these ideals reign Clark men are at home, and all who have them are our friends and brothers.

It is this ideal that sustained us in our darkest days and now lights up the future

with a new glow. Is there any joy of service to be compared with that of the investigator who has wrung a new secret from the heart of nature, listening when she has whispered a single syllable of truth unuttered before, who has been able to add a single stone to the great temple of learning, the noblest of all the structures ever reared by man? Is there any more religious calling than thus thinking God's thoughts after him, and proclaiming the gospel of truth to confirm faith, prevent illness, deepen self-knowledge and that of society, industry, give us mastery over the physical, chemical, biological energies that control the world, and develop mathematics, the language of all who think exactly, a language which all sciences tend to speak in proportion as they become complete? This is why research is religious and the knowledge gained in the laboratory to-day may set free energies that benefit the whole race to-morrow. Is not an institution devoted, heart and soul, to this sort of work, the best thing any community can have in its midst, and should it not be cherished as the heart of this "Heart of the Commonwealth"?

G. Stanley Hall

Clark University

RUSSIAN VERSUS AMERICAN SEALING[1]

In recent discussions of matters relating to the fur seals of the Pribilof Islands great stress has been laid in certain quarters upon the similarity between the recent crisis in the herd's condition and a crisis in which it found itself in 1834, during Russian control. Since 1896 pelagic sealing has been looked upon by the majority of those having to do with the herd as the sole cause of its decline. But in 1834 and prior to that time there was no pelagic sealing, only land sealing. The argument, has, therefore, been that land sealing was common to both crises and hence a probable cause of decline in one as well as in the other.

Land sealing as practised upon the islands since 1868, when the herd came into the possession of the United States, has consisted in the taking of the superfluous young male seals at or about the age of three years, the fur seal being polygamous and its handling being analogous to that of the commoner domestic animals. Pelagic sealing was an indiscriminate form of sealing, conducted in the open sea, while the animals were on their winter migration in the Pacific Ocean or on their summer feeding excursions in Bering Sea, both of which take them far from land. Investigations of the pelagic catch show conclusively that sixty-five to eighty-five per cent. of the animals taken have been gravid or nursing females, with which died their unborn or dependent young.

There can be no dispute regarding these two forms of sealing, as they have been conducted, at least since the beginning of pelagic sealing, about the year 1880; the records are exact and complete. The question therefore turns upon the nature of Russian sealing at and prior to 1834, of which the records are not so complete.

In the debates in congress upon the fur-seal law of 1912, in which land sealing was suspended, as a measure necessary for the protection and preservation of the herd, Senator Shively, of Indiana, made the principal speech in the Senate, taking as his thesis the assertion that the Russians never killed anything but bachelor seals. Representative Goodwin, of Arkansas, made the leading speech in the House and his thesis was that the Russians did not kill female seals. These speeches were alleged to have been based upon the official records of Russian operations. Their purpose was to show that the Russian sealing, which was followed by the disaster of 1834, was identical with that conducted on land by the United States in the disastrous period culminating in 1911, that is—confined to the bachelor seals or superfluous males.

Our knowledge of Russian conditions is derived exclusively from the writings of Bishop Ivan Veniaminof, a Greek-Russian priest, located for the period in question at Unalaska, and a brief extract from the report of an agent of the Russian government, Yanovsky

[1] Presented at the forty-fourth annual meeting of the American Fisheries Society in Washington, D. C., September 30–October 3, 1914.

by name, who made a special investigation of the seal herd in 1820. Bishop Veniaminof's account of the seals was published at St. Petersburg, in 1842, in a work known as the "Zapiski," and comprises pages 349 to 381 of volume 2 of that work. A partial translation of this article has been in existence for some time as an appendix to the fur-seal monograph of Henry W. Elliott, published in 1881, as part of the tenth census. Recently there has been made a complete and more accurate translation, by Professor Raphael Zon, of the U. S. Forest Service, which appears as an appendix to a report on the fur-seal herd by the writer to the U. S. Bureau of Fisheries for 1912, as yet unpublished. It is from this translation the quotations which are to follow are made.

The extract from the report of Yanovsky appears in a letter from the Board of Administration of the Russian-American Company, dated at St. Petersburg, March 15, 1821, and constitutes Letter 6 in the volume of facsimiles in the proceedings of the Paris Tribunal of Arbitration of 1893. A translation of the letter appears at page 58 of volume 2 of the same proceedings in an appendix to the case of the United States. This translation is paralleled by a British version at page 323 of volume 8 of the proceedings, being a part of the British counter case.

These translations of Yanovsky's report differ in one important particular and the essential part may be here reproduced in parallel columns for comparison. The translations are as follows:

American Version	*British Version*
Every year a greater number of young bachelor seals is being killed, while for propagation there remain only the females, sekatch, and half sekatch. Consequently only the old breeding animals remain, and if any of the young breeders are not killed by autumn, they are sure to be killed in the following spring.	Every year the young bachelor seals are killed, and only the cows, sekatch, and half sekatch are left to propagate the species; it follows that only the old seals are left, while if any of the bachelors remain alive in the autumn, they are sure to be killed the next spring.

The difference obviously lies in the use of word "bachelors" instead of "young breeders," in the British version. Accepting this translation the criticism of Yanovsky is that too many bachelor seals were being killed and hence the decline of the herd.

A study of the context, however, readily shows that the word translated "bachelors" in one case and "young breeders" in the other is contrasted with "old breeding animals" in the one case, "old seals" in the other. Internal evidence therefore favors the American translation—"young breeders." This translation is not in itself a logical one, since the animals under consideration are not "breeders" at all, but animals which have not yet attained breeding age. Mr. M. Lippitt Larkin, a Russian scholar, formerly instructor in Stanford University, in translating this letter, has pointed out the fact that, since the Russian, like English, is deficient in a feminine form for the word "holostiaki," here translated "bachelors," the plural might reasonably be taken to cover both sexes, as "men," in phrases like "the children of men," in English, is understood to include both sexes. He suggests that "unmated animals," both sexes being understood, would be a possible, even preferable, translation. If no other light on the question existed than is contained in the letter itself, it would not be necessary to accept the narrow translation of "bachelors" used in the British text.

Fortunately, however, we do not have to depend solely upon the letter itself. The report of Yanovsky was made to the Russian authorities at St. Petersburg. The letter, giving its gist, is one addressed the following spring, that is, in 1821, to the administrator of the Russian-American Company on the seal islands, for his information and instruction. In the article of Bishop Veniaminof, page 369, we find this statement as translated by Professor Zon:

> Only in 1822 Muraview, the head administrator, ordered to leave every year young seals for breeding.

The head administrator did not order "bachelors" left, but "young seals," which

includes both sexes. We have a right to assume that this order was an intelligent interpretation of Yanovsky's recommendation. He had reported that the young seals were too closely killed; the order was that a reserve of such animals should be set aside for breeding purposes.

It may be noted, therefore, that the testimony of the Russian agent Yanovsky is that in the period at and prior to 1820 the Russians were killing young female seals.

The statements of Bishop Veniaminof are much more detailed and definite. In the Zon translation from page 353 of the Zapiski, we read:

> Under the name Kotiki, or gray pups, are classed the four-months-old males and females, which were born in the spring and which form the largest and almost the entire quantity of seals used in the trade.

This means that the Russian sealing took chiefly the gray pups at the age of four months, male and female alike. Amplifying this idea further, we may continue to quote from page 360:

> Some years in September the young pups form large pods and congregate in special places and lie carelessly, so that they all can be driven off without leaving a single one behind. Such pods are very advantageous for the trade but are the most ruinous for the increase of the herd.

The reason for this is made plain on page 364. After describing at considerable length the Russian method of driving and sorting the seals, which was from the breeding grounds and included all classes of animals, he concludes with these words:

> As soon as they are rested the killing is begun with clubs. Small pups which were born the same summer are killed without discrimination, both males and females.

These are very positive statements and there can be no doubt about the translation. They confirm the statement of Yanovsky that the Russians killed the young seals too closely, leaving only the "old breeding animals" for propagation. As these older animals died off in the course of time through natural termination of life, the herd necessarily declined.

The account of Veniaminof adds other details of importance, among them that the general oversight and control exercised by the Russians was inadequate. He says, page 368:

> From the very discovery of the Pribilof Islands (1786) until 1805 . . . the industry on both islands was carried on without any plan, because at that time there were many companies and therefore many masters and each of them attempted to kill as many seals as possible.

As a result of this it was necessary to cease killing for a time, but the irresponsible methods were not reformed and so Veniaminof continues:

> From the time of those close seasons, that is on the island of St. George from the year 1808 and on the island of St. Paul from 1810 to 1822, killing was carried on on both islands without any economy and even with extreme negligence, so that even sikatchi (adult bulls) were killed for their skins and mother seals perished by the hundreds in the drives and in their journeys from the breeding grounds to the slaughtering places.

This is from page 369. Then came the order of Muraviev, already cited, following the report of Yanovsky—to save young seals for breeding. Even this order was disregarded, as we learn from page 371, where Veniaminof tells us,

> It was ordered that more care should be exercised in separating adult and young females from the seals which were being killed, and to try as far as possible to reserve some of those which would regularly be killed.

These are the Russian records in so far as they are available to us. They show that Russian sealing was not confined to the bachelors, as is the land sealing of to-day and that it included females as well as males.

This was all prior to 1834. The efforts toward reform of these early methods failed, one after another, because they were directed toward limitation or suspension of all killing for brief periods and not toward the elimination of indiscriminate killing. With the crisis of 1834 came a complete change in Russian methods. Prior to that time the driving had

been from the breeding grounds, old and young, males and females, being subjected to the strain of the process, the lack of proper oversight and care, rendering it destructive in the extreme. Adult females, young females and female pups were regularly killed. The driving was now limited to the hauling grounds, frequented only by the bachelors, or young immature males, and these animals alone were killed. The females, adult and young, were everywhere protected from driving and from killing. This was the condition of the industry at the time it passed into American control in 1868. The depleted herd of 1834 had been restored to a maximum condition of growth and for twenty years thereafter it yielded a fixed product of one hundred thousand skins annually.

That it has not continued to yield this product was due simply to the fact that there developed, after the year 1880, a new industry carried on at sea, which by 1894 had exceeded in its annual catch the maximum product taken on land. Indiscriminate in its nature, that is, including the females as well as the males and causing the destruction of the unborn and dependent young, male and female alike, the effect of pelagic sealing was necessarily to throw the herd again into decline and in the end to bring it to a state of collapse similar to that experienced in 1834. Neither land sealing as such nor pelagic sealing as such was the cause of this. It was due solely to the killing of females. Just prior to 1911 the killing of females occurred in the sea in connection with pelagic sealing. Prior to 1834 it occurred on land in connection with the undeveloped and unperfected Russian land methods.

As the cessation of the killing of females by the Russians after 1834 stayed the herd's decline and provided amply for its recuperation, so the suspension of pelagic sealing, effected by the treaty of July 7, 1911, is an adequate remedy for the recent decline in the herd and a guarantee for its restoration and future protection.

The suspension of land sealing, incorporated in the law giving effect to this treaty of 1911, was a wholly unnecessary measure—wasteful in the extreme, and certain in the end to be harmful to the breeding life of the herd.

GEORGE ARCHIBALD CLARK

SCIENTIFIC NOTES AND NEWS

DR. AUGUST WEISMANN, professor of zoology at Freiburg since 1867, died on November 6, at the age of eighty years.

THE twenty-third annual meeting of the American Psychological Association will be held in affiliation with the American Association for the Advancement of Science, the American Society of Naturalists and the Southern Society for Philosophy and Psychology at the University of Pennsylvania, Philadelphia, Pa., on December 29, 30 and 31. Professor R. S. Woodworth, of Columbia University, is the president and Professor R. M. Ogden, of the University of Kansas, is the secretary.

THE American Phytopathological Society has selected the Hotel Walton as headquarters during its meeting in Philadelphia, December 29 to January 1. Members should make their reservations at once. Material for the pathological exhibition may be forwarded in care of Dr. Allen J. Smith, Room 214, Medical Building, University of Pennsylvania.

MARTIN G. BRUMBAUGH, Ph.D. (Pennsylvania), governor-elect of the state of Pennsylvania, was professor of pedagogy in the University of Pennsylvania from 1895 to 1900 and from 1902 to 1906, since when he has been superintendent of schools for Philadelphia.

AT the meeting of the Association of American Universities at Princeton University, on November 7, President George E. Vincent, of the University of Minnesota, was elected president; President Arthur T. Hadley, of Yale, vice-president, and Provost Edgar Fahs Smith, of the University of Pennsylvania, secretary. President John Grier Hibben, of Princeton, and President Thomas H. McBride, of the University of Iowa, were elected to the executive committee.

AT the meeting of the Association of State University Presidents in Washington last week, President Benjamin Ide Wheeler, of the

University of California, was elected president and Dr. P. P. Claxton, U. S. Commissioner of Education, and President Harry B. Hutchins, of the University of Michigan, vice-presidents.

On the evening of October 19 a testimonial dinner was tendered to Dr. McCormick by the faculty and trustees of the University of Pittsburgh, on the completion of his tenth year as chancellor of that institution.

At a largely attended dinner at the Sherman Hotel, Chicago, on November 9, the Chicago Pathological Society presented Dr. George Howitt Weaver with an appropriate testimonial of its appreciation of his efficient services as secretary of the society for twenty consecutive years. Short addresses were made by Dr. J. B. Herrick, Dr. Wm. E. Quine, and Dr. L. Hektoen; Dr. Weaver responded.

Dr. Simon Flexner has been in Chicago to study the hoof and mouth disease and will continue the investigation by cultures in the Rockefeller Institute for Medical Research.

Dr. Allen J. McLaughlin, formerly of the Public Health Service, assumed the duties of his office as health commissioner of Massachusetts, at the beginning of November.

Dr. Henry P. Walcott has been reappointed chairman of the Metropolitan Water and Sewerage Board of Boston.

Dr. Arthur Harmount Graves has resigned his position as assistant professor of botany in the Sheffield Scientific School of Yale University, and is at present engaged in research at the laboratory of Professor V. H. Blackman, professor of plant physiology and pathology, Royal College of Science, South Kensington, London.

Mr. F. B. Sherwood, B.S. (1912, North Carolina A. and M. College), has been appointed assistant chemist to the North Carolina Agricultural Experiment Station.

Dr. Jacob Eriksson has resigned the position of chief of the phytopathological experiment station at Stockholm, Sweden.

On account of the war it has been agreed by the University of Chicago and the ministry of public instruction in Paris to postpone the lectures arranged to be given at the Sorbonne by Professor James Rowland Angell, head of the department of psychology and dean of the faculties of arts, literature and science.

Professor William E. Lingelbach delivered his inaugural address as president of the Geographical Society of Philadelphia on November 4. His topic was "Geography in Russian History." He was presented to the society by Mr. Henry G. Bryant, whom he succeeds as president.

On October 19, Dr. C. E. Ferree, of Bryn Mawr College, lectured before the Section of Astronomy, Physics and Chemistry of the New York Academy of Sciences on the efficiency of the eye under different systems of lighting.

The Syracuse Chapter of the Sigma Xi has held two meetings this autumn. On October 2 Professor E. D. Roe reported on the meetings of the American Mathematical Society at Brown University and the American Astronomical Society at Chicago, while Professor F. A. Harvey reported on Professor Rutherford's Washington lectures. On November 6 an address was given by Dr. E. C. Day on "Electric Currents Generated in the Eye by Light" and another by Professor L. H. Pennington on "Studies in Forest Fungi."

At the twenty-fifth anniversary of the Johns Hopkins Medical School, tablets set in the walls of the hospital were dedicated to the honored dead. The *Journal* of the American Medical Association states that one of these tablets is in memory of Dr. John Hewetson who was assistant resident physician at the hospital from 1890 to 1894. Another in the lobby of the main hospital building is inscribed with the name of the late Dr. D. C. Gilman, first president of the university, one with that of Dr. James W. Lazear, who gave his life to study yellow fever and one with that of Dr. Rupert Norton who died a short time ago while assistant superintendent of the institution.

The German newspapers print obituary notices of four university professors killed in

the war. They are Heinrich Hermelink, professor of church history at Kiel; Ernst Heidrich, professor of art and history at Strassburg; Ernst Stadler, professor of German philology at Strassburg, and Professor Frincke, the head of the Hanover-Muenden Forestry Academy. Dr. Julius Liebmann, assistant in the Babelsberg Observatory, has also been killed in the war.

THE Swedish-English Antarctic expedition, headed by Dr. Otto Nordenskjöld, will start in September, 1915, and proceed to Graham Land. The expedition will include twelve members. The Swedish government has granted half the expenses, while the other half will be subscribed in England. This latter money has nearly all been guaranteed.

THE *Journal* of the American Medical Association states that Surgeon Rudolph H. von Ezdorf, U. S. Public Health Service, has completed a malarial survey of Virginia, and reports that he has located breeding places of the malarial mosquito and has taken steps toward its eradication. The next step of the work is the determination of how many people are carrying malaria in their blood, while the third part of the work is educational. The State Board of Health proposes to do a considerable amount of educational and eradicatory work during the year.

STUDENTS in engineering schools are offered an opportunity to compete for $1,000 in prizes for essays on highway construction offered by the Barber Asphalt Paving Company.

ASSOCIATE PROFESSOR J. PAUL GOODE, of the department of geography at the University of Chicago, has in preparation a series of maps for colleges and schools, one of them being a large wall map of South America. In the making of the last-named map, all available official source maps were used, and all the special maps of recent exploration. But in a great area between the Madeira and Tapajos rivers it was necessary to put the legend "unexplored," until the results of Colonel Roosevent's expedition down the "River of Doubt" were published. This map of South America with the location of the new river approved by Colonel Roosevelt, is one of a series of eighteen wall maps for use in colleges and schools upon which Professor Goode has been at work for some years and which is now nearing completion. There is a map of each continent, of the United States, of the world on Mercator's projection, and the world in hemispheres. Each of these is presented as a physical map and also as a political map.

AFTER a period of several years' inactivity the Naturalist Field Club, of the University of Pennsylvania, is being reorganized by Dr. Colton, of the zoological department. Officers elected for the ensuing year are: *President*, R. Holroyd; *First Vice-president*, Miss Lensenig; *Second Vice-president*, S. Harberg; *Third Vice-president*, A. Kolb; *Fourth Vice-president*, Miss Richardson; *Secretary*, Miss Jerdine; *Treasurer*, C. Keeley. The club was organized with the special object of studying natural history in the field. This was done by taking field trips from time to time to different sections of the surrounding country. Observations of birds, flowers, insects, trees and geological formations were made. It is planned to follow out the same plans in the future, the only difference of the reorganized club being in its officers. Formerly members of the faculty held all positions, but in the future the affairs of the club will be in the hands of students. A room in the zoological laboratory will be reserved for the club, and a dark room for the purpose of developing photographs has been arranged.

THE quarterly return of the Registrar-General dealing with the births and deaths in the second quarter of the year, and with the marriages during the three months ending March last, is abstracted in the *British Medical Journal*. The annual marriage-rate during that period was equal to 11.1 per 1,000 of the population, and was 0.1 per 1,000 less than the mean rate in the corresponding quarters of the ten preceding years. The 226,013 births registered in England and Wales last quarter were equal to an annual rate of 24.3 per 1,000 of the population, estimated at 37,302,983 persons in

the middle of the year. The birth-rate last quarter was 2.3 per 1,000 below the average for the corresponding period of the ten preceding years, and 0.4 per 1,000 below the rate in the second quarter of 1913. The birth-rates in the several counties ranged from 16.7 in Rutlandshire and 17.1 in Cardiganshire, to 29.8 in Glamorganshire and 32.3 in Durham. In ninety-seven of the largest towns the birth-rate averaged 25.5 per 1,000, and ranged from 13.1 in Hastings to 34.4 in Middlesbrough; in London the rate was 25.2 per 1,000. The excess of births over deaths during the quarter was 101,879, against 105,808, 102,293 and 105,620 in the second quarters of the three preceding years. From a return issued by the Board of Trade it appears that the passenger movement between the United Kingdom and places outside Europe resulted in a net balance outward of 7,030 passengers of British nationality, and a balance inwards of 13,566 aliens. Between Europe and the United Kingdom there was a net balance inward of 19,308 British and of 15,887 aliens. Thus the total passenger movements resulted in a net balance inward of 41,731 persons. The deaths registered in England and Wales last quarter numbered 124,134, and were in the proportion of 13.3 annually per 1,000 persons living; the rate in the second quarters of the ten preceding years averaged 13.9 per 1,000. The lowest county death-rates last quarter were 8.8 in Middlesex and 10.2 in Rutlandshire; the highest rates were 16.1 in Lancashire and 16.7 in Merionethshire. In ninety-seven of the largest towns the death-rate averaged 13.8 per 1,000; in London the rate was 13.1. The 124,134 deaths from all causes included 3 from smallpox, 307 from enteric fever, 2,677 from measles, 645 from scarlet fever, 2,658 from whooping-cough, 1,122 from diphtheria and 1,428 from diarrhea and enteritis among children under 2 years of age. The mortality from whooping-cough and diphtheria was approximately equal to the average; that from scarlet fever was slightly below the average; and that from enteric fever and measles was about two thirds of the average. The rate of infant mortality, measured by the proportion of deaths among children under 1 year of age to registered births, was equal to 88 per 1,000, or 10 per 1,000 less than the average proportion in the ten preceding second quarters. Among the several counties the rates of infant mortality last quarter ranged from 45 in Buckinghamshire and in Rutlandshire to 110 in Merionethshire and 111 in Lancashire. In ninety-seven of the largest towns the rate averaged 93 per 1,000; in London it was 79, while among the other towns it ranged from 36 in Bath to 143 in Middlesbrough. The deaths among persons aged 1 to 65 years were equal to an annual rate of 7.6 per 1,000, and those among persons aged 65 years and upwards to a rate of 79.8 per 1,000 of the population estimated to be living at those ages.

A SERIES of special lectures on chemical engineering will be delivered in the Mellon Institute of Industrial Research, University of Pittsburgh, as follows:

November 9—"Our New Knowledge of Coal," by Dr. H. C. Porter, chemist, U. S. Bureau of Mines, Pittsburgh, Pa.

November 16—"Recent Researches on the Combustion of Coal," by Henry Kreisinger, engineer in charge of fuel tests, U. S. Bureau of Mines, Pittsburgh, Pa.

November 23—"Some Applications of Pulverized Coal," by Richard K. Meade, consulting chemist, Baltimore, Md.

November 30—"Producer Gas," by Dr. J. K. Clement, physicist, U. S. Bureau of Mines, Pittsburgh, Pa.

December 7—"The Softening of Water for Industrial Purposes," by James O. Handy, director of research, Pittsburgh Testing Laboratories, Pittsburgh, Pa.

December 14—"The Classification of Clays," by Professor Edward Orton, head of the department of ceramics and dean of the College of Engineering, Ohio State University.

January 4—"The Effect of Heat on Clays," by Albert V. Bleininger, director, Technological Laboratory of the U. S. Bureau of Standards, Pittsburgh, Pa.

January 11—"The Manufacture of Structural Clay Products," by Albert V. Bleininger.

January 18—"The Manufacture of Refractories," by Kenneth Seaver, chief chemist of the Harbison-Walker Refractories Co., Pittsburgh, Pa.

January 25—"The Manufacture of Porcelain," by Ross C. Purdy, chief chemist of the Norton Company, Worcester, Mass.

January 25—"Glazes and Enamels," by Albert V. Bleininger.

February 1—"Special Phases of the Glass Industry," a symposium, by Chas. H. Kerr, Pittsburgh Plate Glass Co., Pittsburgh, Pa.; Dr. S. R. Scholes, assistant director, Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh, Pa.; Professor Alexander Silverman, professor of chemistry, University of Pittsburgh.

February 8—"Special Methods of Pyrometry," by Dr. H. S. Stupakoff, director of the Stupakoff Laboratories, Pittsburgh, Pa.

February 15—"The Present Status of the Chemical Technology of Vanadium," by Dr. B. D. Saklat-Walla, chief chemist of the American Vanadium Co., Pittsburgh, Pa.

February 22—"The Manufacture of Steel Tubing," by F. N. Speller, National Tube Company.

March 1—"The Manufacture of Steel in the Electric Furnace," by Professor Fred Crabtree, professor of metallurgy, Carnegie Institute of Technology, Pittsburgh, Pa.

March 8—"The Corrosion of Iron and Steel," by Dr. D. M. Buck, American Sheet and Tin Plate Co., Pittsburgh, Pa.

March 15—"Catalysis," by Dr. M. A. Rosanoff, professor of research chemistry, Mellon Institute of Industrial Research, University of Pittsburgh.

March 22—"Recent Developments in the Electrochemistry of Organic Compounds," by Dr. Harold Hibbert, research fellow, Mellon Institute of Industrial Research, University of Pittsburgh.

March 29—"Industrial Applications of the Phase Rule," by Dr. M. A. Rosanoff.

UNIVERSITY AND EDUCATIONAL NEWS

By the will of Dr. George S. Lynde, of New York, Bowdoin College is left $10,000, Phillips Exeter Academy $20,000, as a memorial to Dr. Lynde's parents, and Yale University is made the residuary legatee. The value of the estate is not given.

The E. H. Skinner Company, of Boston, are now at work constructing a new $25,000 organ for Oberlin College, which will be located in Finney Memorial Chapel. The new organ is the gift of Frederick Norton Finney, of Pasadena, California, and of Charles M. Hall, of Niagara Falls.

The University of Strassburg, like the other German universities, has opened the semester at the usual time.

A member of the faculty of the University of Louvain has been engaged to give courses at the University of Chicago during the winter and spring quarters, his salary to be paid by Chicago. The name of the lecturer and his field of work will be announced later.

The master of Christ's College, Cambridge, states that the university is taking in Belgian students from all Belgian universities, and a committee is endeavoring to organize systematic teaching in French and Flemish, and also hospitality. There are already some fifty students and more than twenty professors in residence. Though the resources of the committee are limited, no student need be kept away by want of means. The master of Magdalen states that there are a number of Belgian professors at Oxford, including nine from Louvain, that a Belgian student's committee has been formed, and that it is intended to give facilities to professors and students for free admission to university institutions and lectures.

Dr. Sidney E. Mezes, president of the University of Texas and previously professor of philosophy at that institution, has accepted the presidency of the College of the City of New York, vacant since the resignation of Dr. John H. Finley to become state commissioner of education.

Dr. James Rowland Angell, professor of psychology and dean of the faculties of arts and literature at the University of Chicago, has been offered the presidency of the University of Washington.

Dr. F. M. Barnes, Jr. has resigned from the faculty of the medical school of the St. Louis University, to become associate in psychiatry in Washington University.

The following additions have been made to the staff of the chemistry department of the North Carolina College: C. F. Miller, B.S.

(Wesleyan, '09), Ph.D. (Cornell, '14); E. L. Frederick, A.B. ('11), Ph.D. (Johns Hopkins, '14); J. T. Dobbins, A.B. ('11), A.M. ('12), Ph.D. (North Carolina, '14).

New appointments at the Rice Institute are as follows: Claude William Heaps, B.Sc. (Northwestern), Ph.D. (Princeton), of Columbia, Mo.; formerly fellow of Princeton University; instructor in physics at the University of Missouri, to be instructor in physics; Arthur Romaine Hitch, B.A. (Washington), Ph.D. (Cornell), of Syracuse, N. Y.; formerly assistant instructor in chemistry at Cornell University, research chemist of the Solvay Process Company, Syracuse, N. Y., to be instructor in chemistry; Herbert Kay Humphrey, B.Sc., in electrical engineering (Illinois), M.Sc. (Union), of Schenectady, N. Y., consulting engineer of the General Electric Company, Schenectady, N. Y., to be instructor in electrical engineering; Joseph Horace Pound, B.Sc. in mechanical engineering (Missouri), of Pittsburgh, Pa.; engineer and instructor in the School of Apprentices of the Westinghouse Machine Company, to be instructor in mechanical engineering; Edwin Eustace Reinke, M.A. (Lehigh), Ph.D. (Princeton), of Princeton, N. J., formerly Proctor fellow of Princeton University, to be instructor in biology; Radoslav Andrea Tsanoff, B.A. (Oberlin), Ph.D. (Cornell), of Worcester, Mass., formerly Sage fellow of Cornell University; instructor in philosophy at Clark University, to be assistant professor of philosophy; William John Van Sicklen, M.A. (Stanford), of Palo Alto, Calif., instructor in chemistry at Stanford University, to be instructor in chemistry.

DISCUSSION AND CORRESPONDENCE

THE ASSOCIATION OF UNIVERSITY PROFESSORS

To the Editor of Science: In the current number of *The Atlantic Monthly* there appears, on one of the pages devoted to biographical sketches of the contributors, a statement concerning the committee on the organization of a national Association of University Professors, to which reference is made in Professor H. C. Warren's valuable article on "Academic Freedom" in the same issue. The statement seriously misrepresents the functions of the committee and the purposes of those inteiested in the organization of the new society; and it is published without the committee's authorization, and, as Professor Warren permits me to say, without that of the author of the article. The committee is in no sense a body for the investigation of grievances or for the examination of internal conditions in American universities. Its only duty is to prepare plans for the formation of a representative professional organization of university teachers. The committee has defined its own understanding of the purposes of the organization as follows:

> . . . to bring about more effective cooperation among the members of the profession in the discharge of their special responsibilities as custodians of the interests of higher education and research in America; to promote a more general and methodical discussion of problems relating to education in higher institutions of learning; to create means for the authoritative expression of the public opinion of the body of college and university teachers; to make collective action possible, and in general to maintain and advance the ideals and standards of the profession.

It may perhaps be well to take this occasion to report to those interested that the committee expects to call a meeting for the formal organization of the association during the last week of December. The day and place can not yet be announced. The committee, after much discussion, determined last spring that members of the profession should, at least at the outset, be asked to adhere to the association as individuals, and not as representatives of their local faculties. The committee is therefore about to send out invitations to a large number of university and college professors who are known to the committee, or to those who have been called upon for advice in the matter, as well qualified representatives of the several sciences. Doubtless, through the limitations of the knowledge of the committee and its advisers, many to whom invitations should be sent will be overlooked. It is not contemplated, however, that the eventual

membership of the association will be limited to those who will be asked to attend this meeting. The committee merely sought, by the means indicated, to bring together a body much larger and more representative than itself, which may constitute a nucleus for the association, and to whose judgment the committee may submit its recommendations.

The committee is not empowered to define authoritatively either the purposes or the scope of the association, or the conditions for membership in it. It is, however, to be expected that the association's future policy with regard to these matters will be determined at the meeting to be held next month.

Since the previous announcement of the *personnel* of the committee, the following members have been added to it:

G. B. Frankforter,
University of Minnesota,
H. B. Mumford,
University of Illinois,
C. E. Bessey,
University of Nebraska,
Samuel B. Harding,
University of Indiana,
Percy Bordwell,
University of Iowa,
T. S. P. Tatlock,
University of Michigan,
J. W. Garner,
University of Illinois,
C. D. Adams,
Dartmouth College.

The chairman of the committee, Professor John Dewey, of Columbia University, or the undersigned, will welcome suggestions from any member of the university teaching profession relating to the plan of organization and the future work of the proposed association.

ARTHUR O. LOVEJOY,
Secretary

BALTIMORE,
November 3, 1914

ATMOSPHERIC OPTICAL PHENOMENA

TO THE EDITOR OF SCIENCE: The letters from Messrs. H. W. Farwell and A. W. Freeman, published in SCIENCE, October 23, 1914, pp. 595–596, are two of the many recent indications of the fact that more attention is now being given than formerly to the observation of atmospheric-optical phenomena. The meteor seen by Mr. Freeman was not, as he supposes, a tertiary rainbow, but the circumzenithal arc of a solar halo. This particular arc is also known as the upper quasi-tangent arc of the halo of 46 degrees.

The complex halo observed by Mr. Freeman at Fredericksburg, Va., November 2, 1913, was visible, in various degrees of development, on November 1 and 2, at a great number of places throughout the eastern half of the United States, and constituted the most remarkable display of the kind heretofore recorded in this country. It should be noted that the small arc, convex to the sun, marked "rainbow" in Mr. Freeman's drawing, was the same phenomenon as that observed by Mr. Farwell, *i. e.*, the circumzenithal arc of a halo. The term "rainbow" is highly inappropriate for this or any other halo phenomenon.

Mr. Freeman's observation is noteworthy on account of including the rare phenomenon of the anthelion—a white mock-sun directly opposite the sun in azimuth, and at the same altitude above the horizon. The large outer circle, shown in the drawing, extending around the horizon, is the parhelic circle, a well-known though rather uncommon phenomenon. The inner, partial circle, drawn parallel to this, is decidedly unusual. It appears to be a secondary parhelic circle, produced by the upper vertical parhelion of the 22-degree halo serving as luminous source. This and other secondary halo phenomena produced by parhelia have been described by Bravais and Besson.

The August number of the *Monthly Weather Review,* which has just appeared, contains a translation of a recent memoir by Besson describing all known forms of halo. No such comprehensive account of these phenomena has heretofore been published in English. The same number of the *Review* contains an extensive report on the halos of November 1–2, 1913.

C. FITZHUGH TALMAN

U. S. WEATHER BUREAU

QUOTATIONS

FOOT-AND-MOUTH DISEASE

In view of the recent outbreak of foot-and-mouth disease in the Mississippi Valley, the most extensive as yet in the United States, a brief consideration of the principal features of the disease may be of interest. It is an acute, highly infectious disease, which occurs chiefly in cattle, sheep, goats and swine, though other animals such as the horse and dog, as well as certain wild animals are attacked also, and it may affect human beings. In animals it is characterized especially by the eruption of vesicles in the mouth and on the feet, in some species more in the mouth, in others more on the feet. It cattle the incubation period averages from three to five days, whereupon a moderate fever with loss of appetite and other general symptoms sets in. In two or three days small blisters appear on the lining of the mouth, and now the fever usually subsides. At the same time one or more feet may show tenderness and swelling of the skin, soon vesicles form here also, and the animal goes lame. In the mouth the blisters may reach half an inch or more in diameter, but usually they are smaller; the contents, at first clear, become turbid, and as the covering bursts, small painful erosions are produced which either heal quite promptly or turn into ulcers that heal more slowly. Usually the milk is altered and reduced in quantity; blisters and ulcers may form on the udder. There is marked loss of weight, as the animals do not eat because of the pain. In this, the ordinary form, in which the death-rate is very small except among the young, the symptoms fade away in from ten to twenty days or so, except when complicating local secondary infections delay recovery, but there are also severe forms with extensive infection of the respiratory tract and gastro-intestinal inflammation, which frequently end in sudden death. In such severe cases ulcers are found in the stomach and intestines. In sheep and swine, lesions of the feet predominate. The disease is transmissible to the fetus in utero.

The cause of the disease is present in the contents of the vesicles, the discharges from the ulcers, the saliva, the milk, the urine and feces, but as a rule not after the tenth day. It is stated that animals having had the disease may carry the virus for months.[1] Any susceptible species may infect any other susceptible species. Infection occurs not only through direct contact, but also indirectly, as the virus retains its virulence for some little time, at least outside the body. Contamination of fodder, of stalls, of feeding and drinking troughs, of milk and milk products and of the hands and clothes of drovers serves to spread the disease, which often travels over wide stretches of country with remarkable rapidity, as shown by the present outbreak. As from 25 to 50 per cent. of the cattle exposed to infection may become sick, there results great loss from fall in the production of milk, from reduction of vitality and fecundity, and from deaths as well as on account of the measures adopted to stamp out the epizootic.

The immunity produced by an attack seems to be feeble, as animals are said to suffer sometimes more than one attack within a short time. So far no practical method of protective inoculation has been developed.

Our knowledge of the cause of foot-and-mouth disease is limited to the fact that it concerns a filterable virus, as yet invisible and incultivable. It was in 1897 that Löffler and Frosch made their classical experiment, showing that the disease is caused by a living, proliferative virus that passes filters which do not permit bacteria to go through, an experiment that has served as a model for all the subsequent work on the many other forms of filterable virus recognized since then. Foot-and-mouth virus may remain active for months if kept cool and moist, but is destroyed rapidly by drying, by heat at 60° C. (140° F.) and above, by formaldehyd and by phenol (carbolic acid). The wide range of virulence of this virus among animal species has been indicated, and as stated, the disease may affect human beings, especially children, being transmitted by milk from diseased cows (experimentally verified) and by butter and cheese made from such milk as well as through

[1] Moore, "The Etiology of Infectious Diseases in Animals," 1906.

wounds and in other ways. While the course usually is favorable, an epidemic described by Siegel had a mortality of 8 per cent. The manifestations are fever, digestive disturbances and vesicular eruption on the lips, the oropharyngeal lining ("aphthous fever") and sometimes on the skin. Where there is danger of contamination of the milk with the foot-and-mouth virus, thorough pasteurization of all milk and milk products is doubly indicated.—*Journal of the American Medical Association.*

SCIENTIFIC BOOKS

Perception, Physics and Reality. By C. D. Broad, M.A., Fellow of Trinity College, Cambridge. Cambridge University Press. 1914. Pp. xii + 388.

The essay of Mr. Broad is the outgrowth of a dissertation presented to Trinity College, Cambridge, at the examination for fellowships. As now published it is an enquiry into the information that physical science can supply about the real. Evidently the speculative tendencies of recent science have attracted the attention of philosophers, and to some extent their envy. As Mr. Broad says: "When a certain way of looking at the universe meets with the extraordinary success with which that of physics has met it becomes the duty of the philosopher to investigate it with care; for it is likely to offer a very much better cosmology than his own unaided efforts can do." This success is due to the fact, he thinks, that most scientists start from a position of naïf realism. The only successful rival, at the present time, to this realism is the phenomenalism which has resulted from the work of Mach and his followers. And this phenomenalism which holds that the objects of our perceptions are non-existent except when they are perceived is not according to Mr. Broad, an adequate foundation for a scientific system. He thus disapproves of the modern physicists who are regarding energy and electricity as entities rather than as attributes.

The essay begins with a discussion of the arguments which have been advanced against naïf realism, and after weighing the evidence he comes to the conclusion "that none of these arguments which are so confidently repeated by philosophers really give conclusive reasons for dropping even the crudest kind of realism." Since it is difficult to advance in science without a belief in some law of cause and effect, he next discusses the arguments which philosophers have advanced against causation. This is followed by chapters on the arguments for and against phenomenalism and the causal theory of perception. The essay closes with a comparison between Newtonian mechanics and the so-called new mechanics which is based on variability of mass with speed. Mr. Broad is quite conservative, for while he does not say that the principles of mechanics which have become classic may not require revision from time to time, yet "the more general laws will still be laws about positions and velocities of some extended quality or qualities, and, as such, will be capable of the same sort of defence that I have offered for the traditional mechanical physics." His opinion is not of great value to the physicist who is not asking for a defence of traditional mechanical physics but who is much worried about the nature of "some extended quality or qualities" which has position and velocity. He is anxious to know whether it is matter, electricity or energy.

The philosophical method of Mr. Broad is that of the neo-realists and he owes much, as he acknowledges, to the lectures and conversation of Mr. Bertrand Russell. His point of greatest departure from Mr. Russell's teaching is perhaps the substitution of the criterion of probability for certainty. This is to make philosophy approach more closely to science. As he says in his introduction: "I have constantly put my conclusions in terms of probability and not of certainty. This will perhaps seem peculiar in a work which claims to be philosophical. It seems to me that one of the most unfortunate of Kant's *obiter dicta* is that philosophy only deals with certainty, and not with probability. So far is this from being the case that to many philosophical questions about the nature of reality no

answer except one in terms of probability can be offered; whilst to some there seems no prospect of an answer even in these terms. Few things are more pathetic than the assumption which practically every philosopher makes that his answer to such questions is the unique possible answer; and few things are funnier than the sight of a philosopher with a theory about the real and the nature of perception founded on numberless implicit assumptions which, when made explicit, carry no conviction whatever, telling the scientist *de haut en bas* that his atoms and ether are mere economical hypotheses." This is a rather long quotation, but it gives very vividly Mr. Broad's philosophical standpoint. While it is a good and safe attitude, one can not help wondering what the value of a philosophical determination of reality may be. Reality which depends at best on its *probable* truth is a doubtful reality and must continue to be a question of dispute. Does it not become ultimately a question of temperament; one either is convinced of the reality of the external world, or he is not, and logic will have but little effect on his judgment?

Mr. Russell and his followers are able to give a specious appearance of certainty to their deductions by employing an esoteric system of mathematical symbols and analysis. He, himself, is both a mathematician and a philosopher. As the former, he must know that mathematical analysis will not give correct conclusions if the postulates contain an error. He must also know that even if the postulates be correct, the conclusion is without meaning if the idea represented by a given symbol should change to an appreciable extent during the transformations. For example, if V represents a *constant* velocity and if, during an experiment, the velocity should change by a measurable amount, then no conclusion could be drawn from our analysis unless V is changed to V', and in addition we know the exact relation between V and V'. The reason why mathematics can be applied to interpret physical and astronomical phenomena so satisfactorily is because the ideas represented by the symbols in those sciences are simple and can be measured with great accuracy. Now this is not the case, except to a much more limited degree, even with the other sciences, and it certainly does not obtain for the far more complex questions of philosophy.

While Mr. Broad employs the method of Mr. Russell more or less throughout his essay, yet he rarely goes so far as to use the very irritating symbolism of his teacher. He has in fact only two specific examples, and of these the one on page 318 applies to a complicated problem of motion; the other example, on page 165, is better suited as an illustration for criticism. Here p is the proposition, phenomenalism is true; and q is the proposition that the objects of our perceptions depend on the structure of our organs. Can we prove p from this? By a manipulation of p and q which is printed so as to resemble a bastard kind of mathematics, he arrives at the conclusion that we can not prove p from the argument. We know that Berkeley was so shocked when he arrived at the same conclusion that he created God so that there might be a reality which could always perceive our organs of perception and thus give them a kind of pseudo-reality when no one else was near enough to perceive them. But that is not the point. It is pretty certain that q stands for so complex an idea or proposition that each of Mr. Broad's n readers will have received an idea differing sufficiently from the others to make it advisable to represent the proposition in these varying aspects by the series $q_1, q_2, q_3, \ldots q_n$. And furthermore, during an extended argument, each one's idea will, I think, change sufficiently to require changes in his q. The result is that q becomes the highly complex series $q_1, q_2, \ldots q_n$; $q_1', q_2', \ldots q_n'$; $q_1'', q_2'', \ldots q_n''$, etc. Not even the mathematical laws of probability can cope with such a problem.

The fact is, no philosophical method has been devised which can settle the questions involved in realism and phenomenalism. But much can be gained by a discussion of the arguments for and against these ideas. And it is in this discussion that the interest and value of Mr. Broad's essay are displayed.

Scientists, especially, should read the book, if for no other reason than to convince themselves how metaphysical their scientific hypotheses are.

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Essentials of College Botany. By CHARLES E. BESSEY, Professor in the University of Nebraska, and ERNEST A. BESSEY, Professor in the Michigan Agricultural College. American Science Series. The eighth edition revised and entirely rewritten. Henry Holt & Co. 1914. Pp. xiv + 409 with 206 illustrations.

The authorship of this essentially new book is unique in American botanical literature, and as a fitting foreword it is a pleasure to recall that the senior author has spent over two score of years in the constant and very fruitful pursuit of botany. The junior author, the son, was therefore reared in an invigorating atmosphere of phytology, since which he has been at the head of the department of botany in the Michigan Agricultural College, the very place where the father began, as an undergraduate, the serious study of the subject conjointly expounded in this text-book fresh from the press.

As a winning football team is sometimes built up around a star player, so here it is quickly noted that the book in hand has a dominant feature, namely evolution, and its title might well be phytophylogeny. In other words in the groundplan one sees fourteen phyla (branches) of the vegetable kingdom arranged in the order of the probable appearance of their members (species) in point of geologic time. The senior author has long specialized in taxonomy, publishing his results from time to time in pamphlet form, as, for example, "A Synopsis of Plant Phyla" (1907), and now the botanical world welcomes the appearance of the present work in which phylogeny is made the keynote of a text-book.

The phylum is the group unit employed for expanding the fundamental doctrine of evolution, namely, that the first species were low plants and from them have evolved all others, thus making all species genetically related, whether far or near, low or high. The lowest of the fourteen phyla is the myxophyceæ (slime algæ)—(the slime fungi find no place in the plant kingdom), and ends with anthophyta (flowering plants). Each phylum has its separate chapter, in which the dominant feature is considered through "laboratory studies" of types followed by a short bibliography. Thus, for example, "phylum V., phæophyceæ—the brown algæ" has for its characteristic idea the addition of the brown pigment, with which certain structural features are associated. This phylum is a lateral divergence from the main evolutionary stem. Again "phylum VIII., bryophyta—the mossworts," is derived from the Chlorophyceæ (simple algæ), shows (*a*) obvious alternation of generations, (*b*) beginnings of conductive tissue and (*c*) the members grow upon land. "Laboratory studies," as usual, are given under the classes, namely, liverworts and mosses.

The last chapter, and last phylum, deals with anthophyta (flowering plants) and includes more than a half of all known plant species. In the laboratory the pupil will here receive the instruction that usually is found in the early pages of the less modern text-books. This chapter closes with a tabulation of the "greater steps" in the development of the highest from the lowest plants.

While the method here followed is logical from the evolutionary viewpoint, as a matter of fact many pupils get into college seriously deficient in botanical perspective, and therefore a few preliminary lessons upon the more evident parts of the higher plants and something of their functions would be advantageous before "making the plunge" into the depths of protoplasm, the most complex of all substances when measured by its boundless activities and possibilities. Therefore it might not be a crime to begin the class with a portion of this last chapter, thus bringing the pupils even by way of review in closer touch with the worldwide out-of-door botany. Next to kinship is social relations, and one wishes that the pupils might be introduced to plant societies, that is, to the environmental factors, namely, ecology,

but that is, perhaps, too far afield for this work, and a companion to it upon field botany may follow.

Concerning the fourteen phyla it is evident that number of species is no criterion as, for example, the calamorphyta with its twenty-four existing species, in a single genus of insignificant plants, stands in the same grade of groups with anthophyta with its 132,000 present-day species. The authors state that "philosophically a phylum originates with the incoming of a new idea. Stated structurally, it has its beginning with the development of a dominant morphological peculiarity. Stated taxonomically its initial point is indicated by the appearance of a new character." So long as the "new character" dominates the phylum remains, but later "ideas" may be expressed, and when they become dominant new phyla arise successively, and thus the phylogenetic tree is built up. It is evident that there might be some difficulty in securing the weights of new ideas in the scale pan of phylogeny, determine the dominance of a "morphological peculiarity" and the appearance in time of a "new character"—all of phylum grade, and therefore so long as the personal equation plays its rôle the last shift in the phylogenetic scheme is not yet made.

The "Key to the Phyla of Plants" follows directly upon the fourteen phylum chapters, occupies fifty pages, brings the classification down through classes, orders to families and under these last 683 groups illustrative genera are named. This feature of the book is closed with reproductions of wall charts showing in one the relationship of the phyla and in the other those of the orders in the anthophyta. These charts will be of great help in genetics and perhaps the publishers may be induced to issue them in large size for classrooms. It is a pleasant thought that these charts, when reduced to page size, suggest at first glance the forms of certain species of algæ and fungi.

The early chapters remind one of the first edition, particularly those upon "Tissues" and "Tissue Systems." More space for greater elaboration seems advisable here, and the single chapter upon physiology needs expanding to three upon nutrition, growth and reproduction, respectively, with possibly one upon pathology—a subject that nowadays can not be adequately treated in four small pages.

Chapter V. "The Chemistry of the Plant" is an assemblage of the plant constituents with their formulæ and occurrence. These pages do not admit of use as either text or laboratory studies, and would make an appropriate appendix, possibly associated with a similar grouping of phytophysical facts and principles.

Twenty-nine pages of index "speak volumes" for the book.

It is a matter of regret that in a text-book where evolution is the fundamental thought the subject of species-making is not presented somewhat fully and even historically in outline. Under the topic "Variations" both "natural selection" and "Mendelism" are touched upon and "mutations" barely mentioned. It is judged that the authors are essentially Darwinians who strengthen their book by frankly stating their ignorance of the way "inherited variations" arise. They are equally wise with their "we do not know" in other places in the text.

As a general criticism, previously hinted, the book seems too small for its contents. The tendency to list instead of to elaborate is felt, due doubtless to a fixed limit of space set by the series of which it forms a unit. The authors have done their work admirably under the pressure, and it is regrettable that the publishers are sometimes at fault. Fanciful colored pictures that inflame the imagination are not asked for, but clear photo- and line-engravings that supplement the text are demanded. Many of the illustrations are too small and "inky"; for example, those under physiology, and give the pages a "pinched" appearance. Even the full-page phylum charts require a reading glass, in parts, for their use. The proof-reader fails at times as in uniformity of type for botanical names of plants (*e. g.*, p. 53).

Botanical teachers and taxonomists and paleobotanists as well, can not but feel deeply thankful for the appearance of this new text-book differing from others in its point of view

and setting down in a concise and clear form the results of many years of very successful study and teaching of the subject presented. It may well become a new starting point for editions that should take on the size and type of illustration that the dignity of a college botany deserves. Here is a hearty welcome to the new text-book in phytophylogeny—The Besseys' Botany Book of Branches.

BYRON D. HALSTED

RUTGERS COLLEGE,
October 28, 1914

Botanical Features of the Algerian Sahara. By WILLIAM AUSTIN CANNON. (Publication No. 178, Carnegie Institution of Washington. 1913. 81 pages, 36 plates.)

The journey of which this paper is an account was made in order "to examine the more obvious features of the physiological conditions prevalent in the region in question and, in connection with these observations, to make some detailed studies of the root-habits of the most striking species of the native flora."

After introductory chapters on the geography and climate of Algeria, the writer proceeds with an itinerary of his trip through the desert. This portion of the paper contains a great deal of topographical detail, together with much that is of directly botanical interest, although presented in a somewhat desultory way. The important botanical data are treated more systematically in the "General Summary and Conclusions" (pp. 66–81).

The author's intimate acquaintance with the vegetation of the southern Arizona deserts makes his comparison of conditions there and in the Algerian Sahara of special interest and value. Some of the striking points of difference as summarized in the concluding paragraphs are: (1) the greater sparseness of the Saharan vegetation, as compared with that of Arizona, there being "probably no large area in southern Arizona, where the soil conditions are favorable for plants, where the water conditions are too meager to support a perennial flora of some sort. The greater aridity of the northern portion of the Sahara is evident, therefore, from the great contrast in its flora." Cannon therefore suggests the term "semidesert" for the Arizona region in contrast with a true "desert" like the Algerian Sahara. (2) The smaller size of the individual plants, at least of the perennial species, in the Sahara. (3) The smaller development of spines. "What may be the proportion of armed to unarmed plants in the northern Sahara I do not know, but to a person familiar with the plants of southern Arizona, where spinose forms are very numerous, the Algerian plants do not appear especially well protected."

Attention is also called to the fact that while in the Arizona desert there are numerous species, among the Cactaceæ and other families which have a "water balance," *i. e.*, which during and immediately after rains store water in their tissues, to be drawn upon in periods of drought; few examples of this adaptation were met with in the Algerian Sahara. Cannon correlates this scarcity of "water balance" plants with the fact that in Algeria there is but one rainy season. He notes that in the Tucson region, where such plants are numerous, there are two rainy seasons during the year, while in the desert region farther west, where but one well marked rainy season occurs, succulent plants are few or wanting.

The author's studies of the root habits of desert plants in Arizona led him to devote especial attention to this feature of the Saharan vegetation. The results of his investigations are summed up as follows: "A study of the relation of the root-type of the Algerian plants to the plant's distribution leads to the same general conclusion already obtained by similar but more extended study in the Arizona desert, namely, that the connection is often a very close one and often of definitive importance. Where the root-type is an obligate type the distribution of the species is much restricted, but where it undergoes modification with changed environment the distribution of the species is much less confined. It is of interest to note especially that as a rule it is the latter kind of root system that is developed by such plants as occur where the soil conditions are most arid, that

is, on the hamada or its equivalent, and not the former, from which it follows that the generalized type of root-system is really the xerophytic type *par excellence,* and not the type with the most deeply penetrating tap-root, as might be supposed." An interesting case of accommodation of root habit to character of the soil is mentioned: "The roots of *Haloxylon* on the hamada at Ghardaia develop both laterals and a main root, but in deeper soil, as at Biskra and Ghardaia also, the laterals are nearly suppressed and the tap-root is the striking feature."

The Algerian desert vegetation was found to have been greatly modified by grazing. In the vicinity of large towns, such as Ghardaia, the cemeteries, which are surrounded by walls, were practically the only places where the native vegetation could be found in a relatively undisturbed condition. The author comments on the fact that certain species, *Haloxylon articulatum,* for example, which are persistently grazed and of which the dissemination would appear to be very difficult, nevertheless remain extremely abundant. It is pointed out that this factor must have been operative even before domesticated animals were introduced into the region, since the native fauna includes several grazing animals. A striking indication of the modifying influence which the persistent action of this factor during many centuries must have had upon the vegetation is afforded by the present distribution of the betoum (*Pistacia atlantica*): "The betoum, which is the largest arboreal species in the Sahara, is confined to the region of the Dayas; that is, to the country immediately south of Laghouat. The tree is unarmed and is eagerly sought after by all herbivorous animals for its foliage and tender twigs. Owing to the presence of such animals, wild and domesticated, the young tree would have no chance to survive were it not that, growing in association with it, is the jujube (*Zizyphus lotus*), which is armed and is not eaten by any animals. The jujube affords safe protection for the seedling betoum, and in its capacity as nurse prevents predatory attacks by animals during the critical period. The survival (and probably the distribution as well) of the betoum is mainly conditioned on the presence of its protector."

At Ghardaia it was observed that many of the perennial species were resuming growth and beginning to flower in November, although no rain had fallen for twelve months. The following explanation is suggested: "Judging from analogy, therefore, it would appear that the stimulus to development on the part of the M'Zabite plants may be from the relatively better water relations made possible by a lower temperature without rain. In November at Ghardaia the evaporation rate is much below that of summer, that during the night being very small. Further, it was told me by good authority that the same species seen growing in autumn renew growth whenever rain chances to come, whatever might be the season. But it should be remembered that rain most commonly occurs in this region in winter, so that the plants may have a rhythm to which they usually conform, but from which they may depart, and that both stimuli (better water relations and lower temperature) are the annually recurring factors by which it may have been induced. Reference, of course, is made to perennials only, as no annuals were seen until the rains of spring made conditions favorable for their appearance."

Exposure appeared to be an important factor in plant distribution only near the northern edge of the desert.

"In parts of the Sahara visited where the most rain is reported, especially Laghouat and Biskra, plants were observed to exhibit exposure preference. Here the south or southerly facing slopes may have a floral composition different from the opposite exposure. In each instance the soil conditions, and apparently the moisture conditions also, were alike." Farther south, at Ghardaia, "provided there is sufficient depth of soil, apparently any species may be found on any exposure."

The numerous excellent illustrations showing the general appearance of various types of vegetation and the habit and root development of characteristic species are an attractive feature of this publication.

The scientific value of the facts and conclusions makes it regrettable that more attention was not paid to the manner of their presentation. The arrangement of the subject matter is not very satisfactory and there is a noticeable tendency to diffuseness and repetition. There is evidence on every page of hasty writing or of inadequate editing and proofreading. The want of precision in statement frequently leads to ambiguity.

These faults of style detract from the pleasure which the reader would otherwise derive from the interesting subject matter. In this respect the present paper is not peculiar, however, scientific writings being all too frequently deficient in literary form. The effectiveness of much good work in science is diminished through lack of care in its preparation for publication.

THOMAS H. KEARNEY

U. S. DEPARTMENT OF AGRICULTURE

British Antarctic "Terra Nova" Expedition, 1910. Zoology, Vol. 1, No. 1. Fishes by C. TATE REGAN, M.A. 4°. Pp. 54. Pl. I.–XIII. British Museum, Nat. Hist., June 27, 1914.

This is the first of the reports on the Natural History of the expedition conducted by the late Capt. Scott, R.N. The Antarctic fishes obtained comprise twenty-five species, of which four are new generic types and twelve species are new to science. Nearly all are from rather deep water. Most of the species belong to the Nototheniiformes. A new genus of the Bathydraconidæ resembles the northern Cottoid *Icelus* in its armature of bony spinose plates and the discovery of an Antarctic species of *Paraliparis* is interesting.

For the first time according to the author, the knowledge of the coast fishes of the Antarctic continent is sufficiently complete to make it worth while to attempt to delimit an antarctic zone and to divide it into districts. South of the tropical zone the distribution of coast fishes is thus classified by him. (1) South Temperate zone with seven districts: Chile, Argentina, Tristran d'Acunha, Cape of Good Hope, St. Paul Island, Australia and New Zealand. (2) Subantarctic zone, with the districts of Magellan and Antipodes, the latter including the island near and south of New Zealand. (3) Antarctic zone with the Glacial and Kerguelen districts. The Antarctic zone is characterized by the complete absence of South Temperate types and Bovichthydæ, and the great development of the other Nototheniiformes. The facts point to the conclusion that Antarctica may have been long isolated and that its coasts may have been washed by a cold sea probably throughout the entire Tertiary period. The author rejects the idea that it may have been connected with South America during recent geological time, as supposed by Dollo in the "Belgica" report. There has also been issued Vol. 11, Pt. 1, containing a twelve-page list of stations where collections were made, with full data, and four maps upon which the positions are indicated.

WM. H. DALL

SPECIAL ARTICLES

THE FAILURE OF EQUALIZING OPPORTUNITY TO REDUCE INDIVIDUAL DIFFERENCES

SEVENTY-TWO students in an undergraduate course in psychology did the experiment described in the note below.[1] Although this was primarily a test for fatigue there was, as is usually the case, an improvement with the

[1] Do experiment 36 at home and record the results. Follow the directions absolutely.

EXPERIMENT 36

Arrange to be undisturbed through a morning or an afternoon or evening. Provide yourself with a watch that records seconds. Multiply mentally, using the examples printed on this page, writing absolutely nothing until you have the entire answer to an example. Then write it and proceed at once to the next. Record the time at which you begin, and record the time at which you have finished each row. Do not stop at all except to record these times until you have finished all the examples or worked at least two hours. Do absolutely the best work you can throughout.

	653	537	927	847	286	728
A.	926	453	384	265	757	487

Nine similar rows were provided.

TABLE I

The Relation of Initial Ability in Mental Multiplication to Improvement: 76 College Students

	Average Score for First Row of Six Examples		Average Score for Final Row of Six Examples Done after Approximately 75 Minutes of Practise		Average Amount of Time Spent in Practise from Mid-point of First Row to Mid-point of Final Row	Gains	
	Amount per Minute	Percentage of Figures of Answers Correct	Amount per Minute	Percentage of Figures of Answers Correct		In Amt. per Minute	In Percentage Correct
Group I. 18 highest scoring....	.61	.86	.68	.87	72	7	1
Group II. 18 next highest......	.36	.80	.39	.80	81	3	0
Group III. 18 next lowest.....	.24	.80	.32	.83	74	8	3
Group IV. 10 lowest scoring....	.143	.76	.175	.78	71	3.2	2

exercise of the function. We may then compare the improvement made in the course of approximately 75 minutes of practise (I count from the mid-point of the first row's time to the mid-point of the time of the row such as makes this time from mid-point to mid-point as near to 75 minutes as possible), by those of initially high and those of initially low scores.

Doing this, we find the facts of Table I., (I.) for 18 individuals whose average score for the first row was at the rate of .61 examples per minute, (II.) for 18 individuals whose average score for the first row was at a rate of .36 examples per minute, (III.) for 18 whose average score for the first row was at the rate of .24 examples per minute, and (IV.) for 18 whose average initial rate was at the rate of .14 examples per minute. As the table shows, the initially high-scoring individuals made an equal gain in speed and somewhat less gain in accuracy, the net results being that they made about as much improvement as the others.

The same result appears in the case of addition where data from some 670 individuals give the facts of Table II.

These experiments add one more corroboration of the general result, so far uniformly attained, that equalizing opportunity does not reduce individual differences. Such experiments furnish a very strong argument against referring individual differences of unknown causation to differences in training, and in favor of referring them to original inherited characteristics in cases where they follow family relationships. We are unable experimentally to equalize training in such gross complexes as scientific achievement, literary fame, or reputation as a monarch. But we can easily do so with various minor capacities

TABLE II

Improvement Made in 1,800 Seconds of Practise at Adding Columns, Each of Ten Digits

Early refers to the ability estimated for the mid-point of the first day. *Late* refers to the ability shown after 1,800 seconds of practise, counting from the mid-point of the first day.

Time Required on Day 1	Number of Individuals in the Group	Number of Additions per 100 Seconds (Counting the Time of Writing the Answers Equal to One Addition's Time)			Approximate Number of Errors per 1,000 Additions, *i. e.*, Wrong Answers per 100 Ten-digit Additions		
		Early	Late	Change	Early	Late	Change
Under 400 seconds............	65	150	162	12	7.0	3.8	3.2
400 to 499 "	108	108	120	12	9.1	6.5	2.6
500 to 599 "	86	88	99	11	10.3	6.7	3.6
600 to 699 "	115	75	87	12	12.0	8.3	3.7
700 to 799 "	109	64	75	11	12.7	9.0	3.7
800 to 899 "	103	55	66	11	12.6	9.3	3.3
950 to 1,199 "	65	46	58	12	14.4	10.5	3.9
1,200 to 1,599 seconds..........	20	37	46	9	17.5	14.4	3.1

such as the ones described here, and can do so without great difficulty with various school abilities.

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PHOSPHATE DEPOSITS IN THE MISSISSIPPIAN ROCKS OF NORTHERN UTAH

SINCE 1908 extensive work has been done both by private individuals and the U. S. Geological Survey to determine the amount and character of the rock phosphate in the Rocky Mountain region. The principal work of the investigation of the deposits, however, has been confined to the well-known horizon in the rocks of upper Pennsylvania of Permian age. It is now known that phosphate exists in the Mississippian rocks in a zone more than 2,000 feet stratigraphically below the phosphate horizon that has heretofore been given so much study.

The zone containing the phosphate is more than 100 feet thick and consists of layers of phosphate and black and brown shale with interstratified layers of sandy limestone. In extent it is known to outcrop in a north-south direction for more than forty miles, and sections studied show it to have an area of more than one hundred square miles. It has been reported as far south as Ogden Canyon[1] but no detailed section has been measured in that locality.

On the east side of Cache Valley the phosphate rocks have been prospected for coal and this exposure has given the best opportunity for detailed study. The face of the mountains which form the eastern boundary of the valley is a weathered fault scarp which terminates the western limb of a syncline. The ledges on the face of the mountain are exceptionally well exposed, the rock being principally bluish gray limestones with thin beds of shale and quartzite. Here the geologic section is well exposed and shows Silurian rocks at the base and Pennsylvanian at the top of the succession. Only the lower members of the Pennsylvanian or Permian are present in this locality.

[1] Blackwelder, U. S. Geol. Survey Bull., 430.

Observations on the face of the mountains, which extend more than 4,000 feet above the valley, show that the rocks strike N. 10° to 14° E., and dip eastward from 20° to 30°. The beds flatten to the eastward and about six miles east of the face they rise again, the strata on the eastern limb of the syncline dipping as much as 10° to the west. Erosion has clearly exposed the higher beds on the eastern limb of the syncline.[2] The phosphate rock is exposed on both the east and west limbs of the syncline which lies near the top of the range.

The Logan River has cut through the range from east to west, and has made a good exposure of all the strata included in the upper part of the synclinal fold. The phosphate zone, therefore, lies in two separate areas, one to the north and one to the south of the river. The Mississippian rocks are well up on the western side of the mountains forming the eastern boundary of Cache Valley and even in the lowest part of the fold in the canyon they are more than 1,000 feet above the river.

The zone containing the phosphate is exposed in a cliff of very compact bluish gray limestone which is usually more than a hundred feet thick and contains an abundance of cup corals. At the base of this cliff there is a lean phosphatic zone from five to seven feet thick of shale containing a few bands of chert. The shale also contains several thin layers of oolitic rock phosphate ranging from one half to one inch in thickness. One sample taken from all of these layers yielded only 7.21 per cent. tricalcium phosphate. This zone is probably of no economic value. It has been prospected in a number of places for coal.

The thicker and richer phosphate zone lies just above the thick ledge of limestone. The phosphate rocks are less resistant to erosion than the underlying and overlying limestone ledges and the latter stand out more prominently than the included softer beds. The rocks in the phosphate zone which are generally dark colored contain thin bands of nonphosphatic limestone with shale and some

[2] See Geological Map—parts of western Wyoming, southeastern Idaho and northeastern Utah—Hayden survey, 1877.

chert. Measurements of some of the beds were taken in Providence Canyon and are shown in the table below.

At the top of the phosphate zone the rocks are not sufficiently well exposed to afford detailed study. A tunnel driven near the upper limestone ledge shows a few inches of good rock phosphate interstratified with dark-colored limestone and shale.

Thirty feet below this ledge twenty inches of oolitic phosphate rock was measured and a sample (No. 1) yielded 55 per cent. $Ca_3(PO_4)_2$. In the next thirty feet below there are thin bands of oolitic phosphate but none of them are believed to be thick enough to be of economic value. The details of the lower part of the bed in Providence Canyon follow:

No.	Kind of Work	Per Cent $Ca_3(PO)_4$
	3 feet dark gray limestone	
2	18 inches phosphatic shale	30.10
3	12 inches shaly phosphate rock	16.71
4	48 inches dark shaly phosphate rock...	65.43
	24 inches gray limestone	
5	48 inches shale, some layers phosphatic.	14
6	11 inches black shale	8.41
7	30 inches shale, oolitic phosphate, in bands	21.30
	24 inches sandy limestone	
9	38 inches phosphate rock, shaly	33.01
	18 inches chert	
	12 inches black shale	
10	30 inches phosphate rock	35.83
11	12 inches phosphate rock	46.34
	2 inches black chert	
12	48 inches black shale	3.91
	6 inches black chert	
13	21 inches black oolitic phosphate rock..	65.76
	1 inch black chert	
14	12 inches black shaly phosphate rock..	21.40
15	18 inches brown oolitic phosphate rock.	68.59
	bedding planes	28.31
	6 inches shale	
16	6 inches shale showing phosphate in	
	2 inches chert	
17	4 inches shaly phosphate rock	27.12
	20 inches sandy limestone	
18	18 inches brown oolitic phosphate rock.	66.9
	12 inches black shale	
	16 inches black shale with bands of chert.	
	5 inches brown oolitic phosphate rock.	52.22
	7 inches shale	
	2 inches oolitic phosphate rock with much hematite	
	Limestone ledge	

The samples for analysis were taken only two or three feet under the surface and it seems quite probable that they have been considerably leached for the rock is less firm and crumbles more easily than that from the upper Pennsylvanian or Permian horizon. No sampling has been done below the level to which roots penetrate. It is thought the amount of phosphate may decrease to some extent with depth, owing to the leaching of the less soluble constituents and the concentration of the phosphoric acid in the leached zone.

One very noticeable feature in the phosphate zone in this locality, which is an aid in tracing the phosphate, is that usually the growth of vegetation is denser along the line of outcrop than elsewhere. On hillsides which face the south and, therefore, have but little moisture or vegetation, growths of wild cherry, maple, and aspen extend along the outcrop. As a few small seeps and springs issue from the phosphate shales the denser vegetation there should perhaps be partly accounted for by the moisture.

At a place four miles north of the locality in Providence Canyon where the samples mentioned were obtained, two other samples were taken from separate layers of oolitic phosphate rock near the lower part of the deposit. The sample from one bed 18 inches thick yielded 55.21 per cent. tricalcium phosphate.[3] The other sample from a bed 42 inches thick yielded 61.32 per cent. of the material. The section does not seem to agree in detail with the measurements made in Providence Canyon. It is thought by the writer that the Mississippian rocks are sufficiently rich in tricalcium phosphate to warrant investigation as to their economic value.

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[3] The analyses were mostly made by Mr. C. T. Hirst in the Experiment Station chemical laboratory.